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DEPARTMENT OF MINES.

GEOLOGICAL SURVEY OF QUEENSLAND.
Publication No. 191.

NOTES

ON

TIN, COPPER, AND SILVER MINING

IN THE

STANTHORPE DISTRICT

(WITH 13 PLATES).

By LIONEL C. BALL, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

BRISBANE:
BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

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LETTER OF TRANSMITTAL.

Queensland Geological Survey Office,
Brisbane, 13th March, 1904.

Sir,—I have the honour to forward for publication Mr. Ball's "Notes on Tin, Copper, and Silver Mining in the Stanthorpe District."

A short visit of inspection was made by Mr. Ball at the end of 1903, and the notes he has compiled bring up to date all the information concerning mining developments in that part of the State.

The notes embrace—

(1) A general review of tin-mining at Stanthorpe, including a description of ground-sluicing, dredging, and lode-tin mining;

(2) An account of recent developements at the Sundown Copper and Tin Mines, at the Silver Queen Mine, Severn River, and at the Pikedale Silver Mines; and

(3) A description of the silver and copper mines in the neighbourhood of Texas.

I have, &c.,

B. DUNSTAN,
Acting Government Geologist.

To the Under Secretary for Mines.

TABLE OF CONTENTS.

PAGE.

1.—*Notes on Tin-Mining in the Stanthorpe District* 9

I.—PAN-WASHING AND CRADLING 9

II.—GROUND SLUICING 9

(*a*) Sugarloaf Creek 9
(*b*) Severn River 10

III.—DREDGERS 11

(*a*) New Wylie Creek Company 11
(*b*) Stanthorpe Proprietary Company 13
(*c*) Broadwater Proprietary Company 15
(*d*) Sheahan's 17
(*e*) Prospecting on Four-Mile Creek 17

IV.—LODE TIN-MINING 19

(*a*) Ballandean Tin-Mining Company 20
(*b*) Late Prospecting at Red Rock 20

2.—*Notes on Copper and Silver Mines near Stanthorpe* 21

I.—SUNDOWN COPPER MINE 21

II.—WORKINGS IN THE VICINITY OF THE SUNDOWN MINE 23

III.—SILVER QUEEN SILVER MINE 23

IV.—PIKEDALE SILVER MINE 25

3.—*Notes on Mines near Texas* (*Stanthorpe District*) 25

I.—SILVER SPUR SILVER MINE 25

(*a*) Locality 25
(*b*) History 25
(*c*) Mining 26
(*d*) Output 26
(*e*) Surface Plant 26
(*f*) Geology 27
(*g*) Ore Bodies 28
(*h*) Treatment 32

II. TEXAS COPPER MINE 37

III.—SILVER KING SILVER LEAD MINE 37

IV.—SILVER CROWN SILVER COPPER MINE 37

4.—*Appendix* 38

LIST OF ILLUSTRATIONS.

		Facing Page
Plate 1	Wylie Creek Dredger, N.S.W.	10
,, 2	—Fig. 1: Wylie Creek Dredger, Stern View...	12
	Fig. 2: Wylie Creek Dredger, Bows	12
,, 3	—Willoughby Machine, Plan and Elevation...	12
,, 4	—Stanthorpe Proprietary Dredger	14
,, 5	—Stanthorpe Proprietary Dredger, Bows	14
,, 6	—Stanthorpe Proprietary Dredger, Stern	14
,, 7	—Stirring Rakes, Stanthorpe Proprietary Dredger ...	14
,, 8	—Prospecting Boring Plant, 4-mile Creek, Stanthorpe ...	18
,, 9	—General Surface View, Silver Spur	24
,, 10	—Surface Plant, Silver Spur	26
,, 11	—Roast Heaps, Silver Spur...	32
,, 12	—Copper Reverberatory Furnace, Silver Spur	32
,, 13	—Old Lead Blast Furnace, Silver Spur	34

NOTES ON TIN, COPPER, AND SILVER MINING IN THE STANTHORPE DISTRICT.

(WITH THIRTEEN PLATES.)

I.—Notes on Tin Mining in the Stanthorpe District.

The tin-mining industry in the Stanthorpe district has always depended on the alluvial, none of the lodes hitherto discovered having proved either rich enough or permanent enough for exploitation. Very little can be added to what Mr. Skertchley has said in his report* on the district with regard to the ordinary primitive methods of saving the tin; but since that report was written dredging has been introduced, and should prove in numerous cases a pronounced success. It is my opinion, and that of experienced tin-mining engineers from other States, that there is a bright future before Stanthorpe, but that capital and modern appliances for the economical treatment of large quantities of material are necessary in order that the tin ore still in the "wash" may be saved.

I.—PAN-WASHING AND CRADLING.

Pan-washing and cradling have now practically gone out of use in favour of box and ground sluicing. Just at the time of my visit (November-December) there were very few men on the alluvial, even the ordinary average having been reduced owing to the swollen state of the creeks, due to late rains. There are believed to be about 100 alluvial men in the district, but I think that greatly in excess of the number. Most of the work done by these men is working over the old alluvial, sometimes for the third time; but some of the creek beds are found to be worth attending to after every flood.

II.—GROUND SLUICING.

(*a*) Sugarloaf Creek.

Most of the tinstone now being got is from the Sugarloaf Creek district, and the greater part of that is brought in by Chinese. Part of the old Brisbane claim has been subleased to one of them, who employs ten men, and has done a large amount of work—turning over old tailings chiefly. A large stream of water is brought in a race from a point on Sugarloaf Creek, 2½ miles distant, and by its aid the old tailings, to a depth of 10 feet, are sluiced down. On the bottom is a bed of "cement," 2 to 4 feet thick, which the Chinamen do not attempt to penetrate, though it is believed that wash exists underneath it. The great difficulty in ground sluicing is the liability to failure of the water supply, droughts, even in this district, causing stoppages for several months in the year.

No information could be obtained from the gentleman in charge, because of the want of an interpreter. It is considered that five sluicers should put

* G.S.Q. Publication, No. 120. Geology of country round Stanthorpe and Warwick, with especial reference to the Tin and Gold Fields and the Silver Deposits. By Sydney B. J. Skertchley, late Assistant Government Geologist. Brisbane: By Authority. 1898.

through 20 cubic yards a day, so that ground carrying 4 lb. of tinstone per yard would yield a profit of 9s. 9d. per man, with tinstone at 68s. per cwt., the present (December) local price. The ground worked by the Chinamen contains probably less than 2 lb. per yard.

(*b*) Severn River.

Locality.—During the last few months Prospecting Areas 47 and 48 have been pegged out on the Severn River, 6 miles west of Ballandean Railway Station, and 14 miles south-west of Stanthorpe. P. A. 48 includes a flat-topped ridge, 10 chains wide, running parallel to and on the left side of the river, and rising 60 feet above it. P. A. 47 is in the gully to the west of the ridge. In addition to the above, the company holds a 20-acre water area, which takes in a waterhole 20 feet deep, 1 chain wide, and 10 chains long, adjacent to P. A. 48.

Geology.—The occurrence of rich residual surface tinstone here is mentioned by Mr. Skertchley*, and is shown on his map, so that this is not a new discovery, but simply an attempt to work ground not hitherto considered payable.

The country rock on the claims consists of granite and greisen (with north-north-west master-joints), exposed by denudation of the overlying slates, but as yet very little eroded themselves—that is to say, the rock exposed is the uppermost portion of the intrusive mass. A large part of the granite has been greisenised, owing, as Mr. Skertchley explains, to the spreading out at the base of the slates of the "greisenising liquids" (or, more properly, the pneumatolitic solutions) from the granite. In one place on P. A. 48 the greisen forms a large outcrop, and several trenches have been cut on it. A shaft was sunk 30 feet in it, coarse tin being found in places, with a little wolfram and molybdenite, and also a few patches of mispickel. A number of trenches have been cut, and some of the heaps beside them yield as much as ¼ oz. of coarse tinstone (crystals up to ½ inch in diameter) to the dish. Two tons of tin are reported to have been obtained from this locality—apparently from rich but scattered bunches.

Mr. Baker, who is in charge of operations, expects that 30 acres of the ground will average from 2 to 4 feet of soil, yielding 4 lb. of tinstone to the yard. The whole thing depends on the testing of the ground, which requires a large number of holes.

Plant.—Water will be raised from the waterhole to the highest point on the ground by a 16,000-gallon Knowles duplex pump, which has been erected on a rocky platform 10 feet above the ordinary level of the water, but below flood level, and is to be served with steam from a Pennsylvania marine-type multitubular 12-horsepower boiler, situated 25 feet above the water and clear of floods. The water will be forced from the pump through 6-inch flanged galvanised iron Zollner pipes, which are made in 18-feet lengths, weighing 50 lb. each, and specially suitable for transport to such inaccessible places as this. They have been tested to 200 lb. pressure, so that it will be possible, if future operations show it to be advisable, to undertake hydraluicing with the present plant.

The method of working will consist in having five or six main races radiating from the topmost point; into them the soil from the intervening ground will be sluiced, the soil being washed down into the river and the tinstone left behind.

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* *Op. cit.*, p. 48.

Photo., L.C.B.

WYLIE CREEK DREDGER, N.S.W.

SHOWING REVOLVING TROMMEL, SLUICE BOXES, AND LONG TOM.

Great trouble was experienced in getting the machinery on to the ground, owing to the road from the railway reaching only to Ballandean head station; beyond this a track had to be cut across a precipitous range, which might have been escaped, and the river bed followed, but for the floods just then prevalent.

III.—DREDGERS.

There are two dredges in the Stanthorpe district, in Queensland, and one in the continuation of the same country in New South Wales. Owing to the late drought they were able to do nothing till the middle of last year. That in New South Wales is now on a dividend-paying basis, and a description of it is given below for comparison with the Queensland dredgers, one of which is now in a fair way to successfully work its ground. I have to acknowledge the great assistance rendered me in each case by the manager.

(*a*) New Wylie Creek Dredging Company

(Mr. Bryce, manager).

The New Wylie Creek Dredging Company has a nominal capital of £31,000, of which £29,000 has been allotted in 10s. shares. Three leases, amounting to nearly 200 acres, are held from the Crown.

Locality.—Wylie Creek is a tributary of Harding Creek, which flows into the Clarence River.

The present dredger is 3½ miles below Wilson's Downfall, on the Stanthorpe-Tenterfield road, 5½ miles from the Queensland border, and 15 miles by road from Stanthorpe. It lies on a large 27-acre flat (practically all worked over by the earlier miners), near the lower end of the leases. The creek for miles below this has been worked by miners, but it is not considered dredgable. On account of the success of the first dredger a proposal is now being considered to erect another about half a mile up stream, where the ground, being too deep for the miners, is expected to be richer than the old tailings.

Ground.—According to the borings, which were made in rows 10 chains apart, the ground should carry 2 lb. of tinstone per yard, but the dredger during the last half-year saved only ¾ lb. per yard, and as the manager believes he saves 75 per cent. of the tin ore put through the dredger. the total in the wash cannot be more than 1 lb. Just at present slightly better results are being obtained, but it is probable that the dredger will be turned, and its tailings put through as a test. The ground which thus far has given best results is what was too poor for the miners, and consequently untouched by them.

The average depth of the ground is 14 or 15 feet over the whole of the dredgable portion, and the average width is 7 to 8 chains. The bottom is a soft decomposed granite. Little trouble is experienced with boulders, only one bank of them having yet been encountered; and, just at present (November), the dredger is passing through fine drift sand.

Dredger.—The new Wylie Creek dredger was finished by the end of 1901, but, owing to the drought, a start could not be made till March, 1903, and then the water to float it had to be pumped into the paddock for a month or two. Till June only one shift of men (working eight hours a day) was employed, in August a second was put on, and now three shifts are working.

The dredger is of the ladder-bucket form, and cost between £6,000 and £7,000. The pontoon is 40 feet in length by 20 feet across (dimensions approximate), and owing to its comparative shortness, the heavy sluice boxes at the stern cause that end to sink a couple of feet deeper than the bows, even

though numerous large half-ton boulders dredged up are used as ballast. The machinery (including the buckets, winches, and pumps) was supplied by the Clyde Engineering Works, and is all driven by a 12-horsepower compound engine.

There are 27 buckets, of 4 cubic feet capacity, provided with tire-steel lips, and spaced 4-feet centres, and the ladder allows dredging to a depth of 20 feet. The material raised by the buckets should be thrown on to a manganese steel "dropshoot," but while in shallow ground the buckets do not pass within 6 inches of the shoot, and then much of the wash (often half a bucket) misses the shoot and falls down the well into the paddock again. This represents a serious waste, so that an easily adjustable shoot is a pressing want. Mr. Bryce has computed that the buckets are capable of raising 8,000 or 9,000 tons of material a week, though, since August, they have been raising only 5,000 to 6,000 tons, owing to defects in the sluice boxes.

A stream of water, raised by a 10-inch centrifugal pump, sweeps the wash down the shoot into a revolving trommel or screen, 4 feet in diameter and 8 feet 6 inches long, punched with $\frac{3}{8}$ and $\frac{1}{2}$-inch holes. All the tin ore here being very fine, $\frac{5}{16}$-inch holes would, in Mr. Bryce's opinion, be quite large enough. If the material were put through two screens, preferably concentric, there would be far less material to go over the tables, and a greater amount of wash could be put through in a given time, with a correspondingly greater chance of saving the tin.

From the trommel the coarse material discharges onto a shoot and is washed out astern, while the finer wash, carrying the tinstone, passes through the screen onto side shoots (one of which, it is interesting to note, owing to the motion of the trommel, receives nearly double the quantity of the other), and thence is swept on to two sluice boxes or tables running out beyond the stern. These boxes are 4 feet wide and 40 feet long, and are built of iron. The sand is kept 6 inches deep in them, and under 3 inches of water. Most of the tinstone is saved within 5 feet of the top of the tables beyond the trommel shoots. One man with a shovel is stationed there, and keeps the sand stirred up, while, at present, for experimental purposes, another man shovels back the sand in the lower part of the sluices. Owing to the tables not being able to discharge the "wash" from the trommels quickly enough the buckets have to be stopped every now and then; but for this there are two available remedies—namely, to widen the sluice boxes (Mr. Bryce would have them double their present width), or else to use a double screen, as proposed above, so that less of the material raised would have to pass over the tables.

The concentrates from the tables average 7 cwt. to the yard, and are sluiced off in a long tom (10 feet long and 18 inches wide), by two men on the dredger, and then taken ashore to the Willoughby machine shed for final cleaning.

Normally five men are employed on the dredger on each shift, an engineer (who is also winchman and engine-driver), and two men on each sluice box. When the photographs were taken there were two more men on the dredger attending to the long tom. In addition to the above two men are employed in the day shift loading wood, which it may be mentioned costs 8s. a cord here.

Cleaning.—The black and white sand (including a few small topazes), is separated from the ore in a Willoughby machine, which acts on the principle of an upward current separator, and is the invention of a Stanthorpe man. It consists (*see* Plate 3) of an outer tank, with hand pumps and pressure box (if a stream of running water is not available), and a separating box, with false

Photo., L.C.B. FIG. 1—WYLIE CREEK DREDGER, STERN VIEW.
LOOKING UP THE SLUICE BOXES.

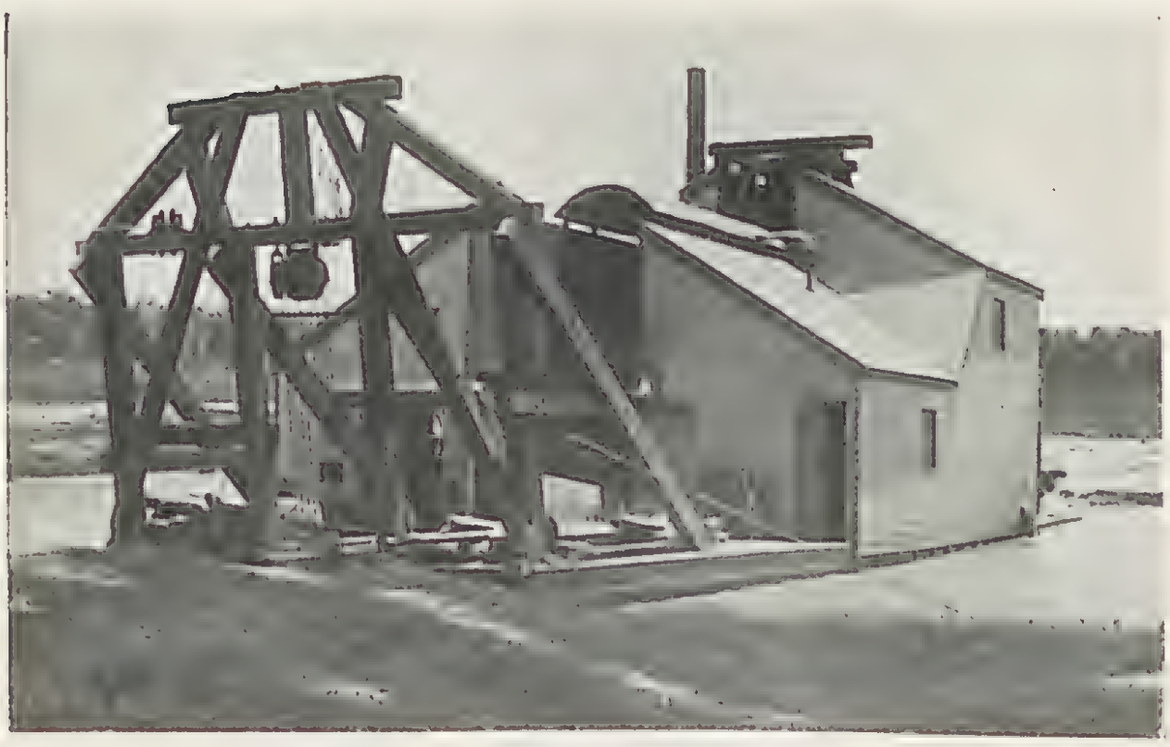
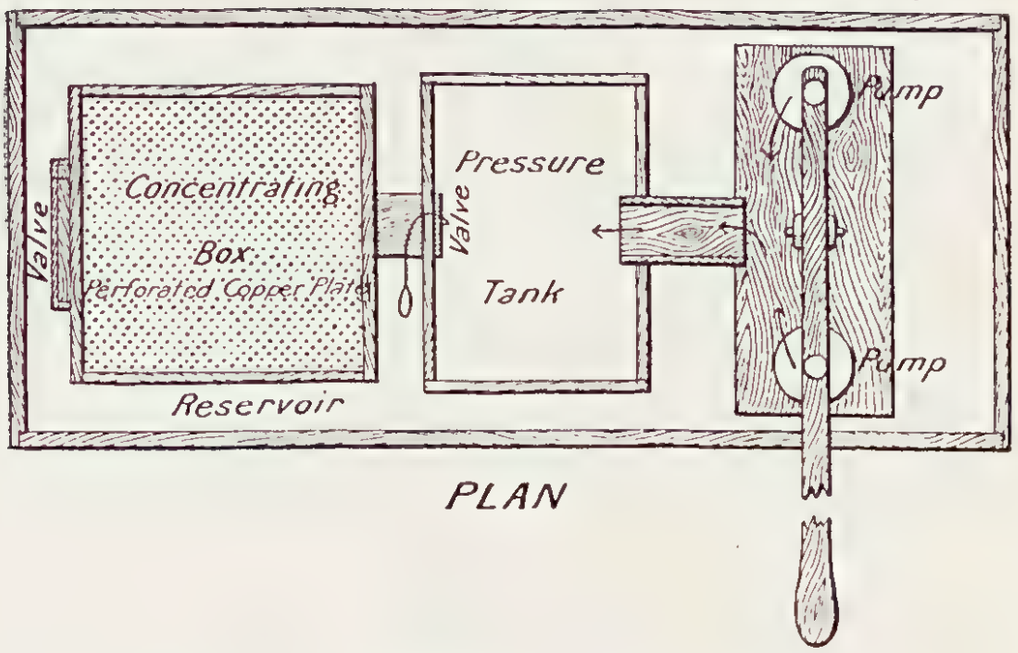


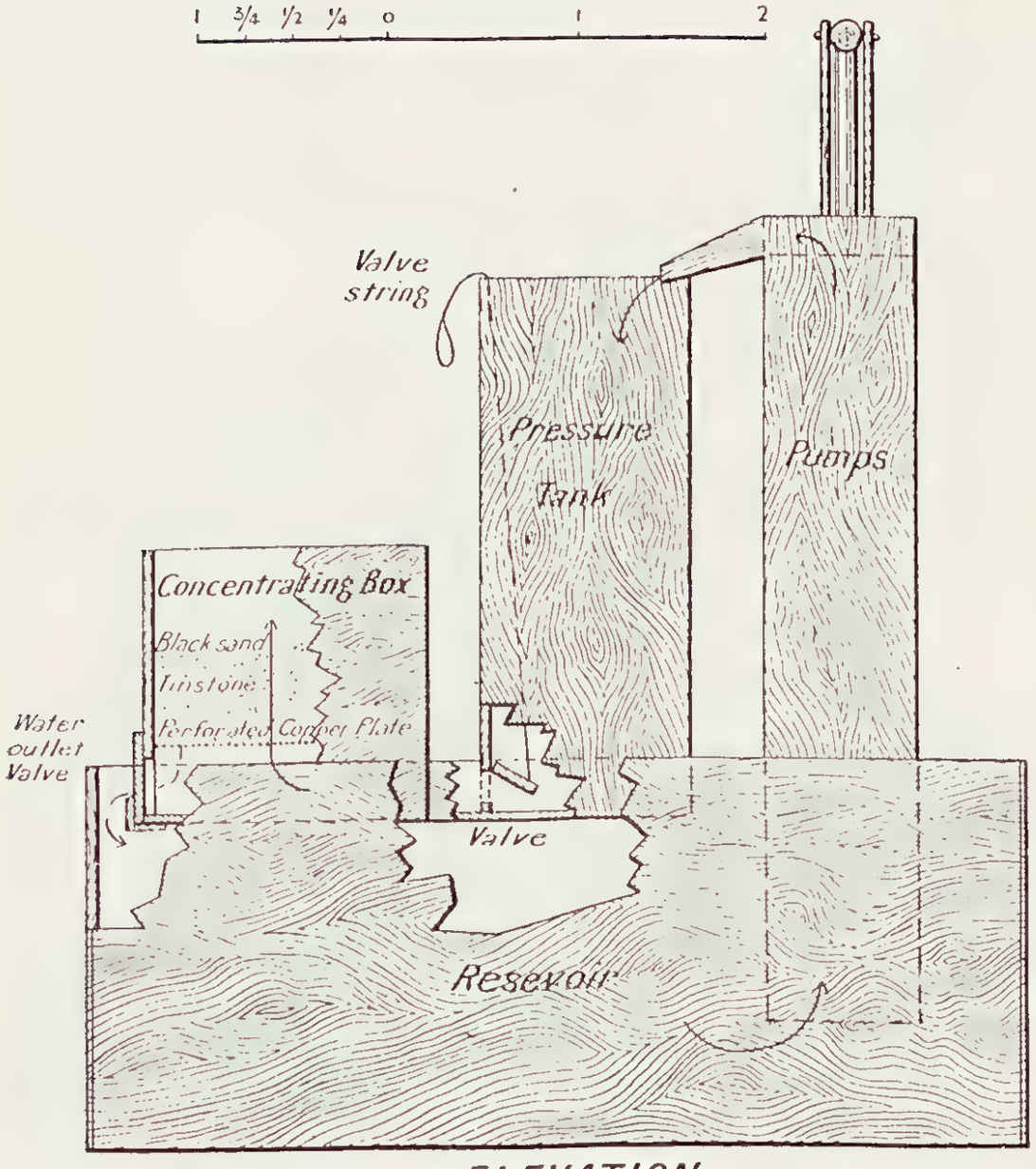
Photo., L.C.B. FIG. 2—WYLIE CREEK DREDGER, BOWS.
SHOWING DREDGER CUTTING INTO BANK OF OLD TAILINGS.



PLAN

Scale of Feet

1 3/4 1/2 1/4 0 1 2



ELEVATION

DIAGRAMATIC SKETCH OF WILLOUGHBY MACHINE.

bottom (a copper plate with $\frac{1}{32}$-inch perforations). The crude ore, about 4 cwt., is placed in this box to a depth of 6 inches, and a stream of water under a head of from 1 to 3 feet is allowed to rise through it, causing the lighter impurities to ascend to the top, where they are scraped off. The operation is repeated about five times, and then the cleaned tin ore (cassiterite) is dried on an iron plate (10 feet by 5 feet in area), heated over a grate. The tinstone, as bagged for shipment, averages 76 per cent. of tin (varying from 75.3 to 76.4 per cent.).

Returns.—On the dredger's trial run 30 cwt. of tin ore was obtained after 255 hours from 10,000 tons of wash, which, however, according to the boring results, should have yielded 10 tons. About 40 tons of ore have thus far (November) been obtained, together with 4 tons of black sand. For the week ending 21st November, 50 cwt. of tinstone was obtained from 5,500 tons of wash on a 114 hours' run. Of this amount between 15 and 20 cwt. probably paid expenses, leaving a very fair profit.

The first dividend of 3d. was declared in October, and was followed by a second in November, and a third in December.

The table below has been compiled from weekly returns published in *The Border Post*:—

Month.	Yield of the Ore.	Hours Working.	Dividends.
	Tons cwt.		s. d.
December, 1903	8 16·5	397	0 3
November	9 5	436	0 3
October (two weeks)	3 9	306½	...
September	8 10	371	0 3

The best result was thus about ½ cwt. of tin ore per hour. The Sydney quotation for tin at the end of 1903 was 21s. 6d. per unit.

Conclusion.—The Wylie Creek dredger can now be considered a success, the long interval of inaction between erection and actual working being entirely due to the drought. Mr. Bryce attributes his success to the use of the revolving screen in the first place, and to the employment of a sufficient number of men in the second. The location of the dredger is on a large flat, and the fairly uniform and fine nature of the material treated are prime factors, though the separation by the screen of the coarser stuff has undoubtedly had a very beneficial effect on the saving of the tin and on the total amount of material put through.

It is understood that lately the water has become scarce, and it will probably be necessary to construct a dam above the dredgers for a reservoir.

(*b*) Stanthorpe Proprietary Tin Dredging Company

(Mr. Martyn, manager).

Locality.—This is a Sydney company, of 25,000 shares, of which the 10,000 are paid up to £1. Leases up to a quarter of a mile in width have been secured from private owners for a distance of 2½ or 3 miles along Quart-pot Creek. These are on the bend round the old Brisbane claim, which has been considered one of the largest and richest alluvial areas in the district. The dredger lies at the south-western and lower end of the leases—3½ miles in a direct line a little south of east of Stanthorpe, the distance by road being 5 miles.

Ground.—Owing to insufficient prospecting by borings, the dredger was erected in one of the worst possible positions, being cut off from the creek by a bar of granite, and from the higher wash by a bar of "cement" a chain wide, running diagonally up the creek for a quarter of a mile. The dredger has done little more during the last six months than cut its way to a depth of 11 feet through this bar.

This "cement" occurs in flat layers from a few inches to several feet thick, and from a few square yards to several acres in area, at various depths beneath the surface. Though generally poor itself in tin ore, there is often tinstone both above and below it. It is composed of granite detritus, chiefly grains of quartz, in a felspathic matrix, and in my opinion it owes its origin to the action of carbonic acid solutions on the felspars. These solutions may have been derived from decaying vegetation above, and have sunk into the rotten granite, causing a complete decomposition of the felspar, the potash going off in solution, while silicate of alumina was precipitated as a cement. The occurrence of occasional rounded pebbles in it might be explained by their having sunk into the mass before the secondary alteration and solidification took place. This rock has been found in most of the workings about Stanthorpe, and will prove one of the most serious obstacles to bucket dredging there.

It is believed that the wash has been mined under the "cement," and it is therefore not intended to drop the buckets to the bottom till the old ground beyond the "bar" is reached. At the end of November softer cement was entered, and the amount of tinstone saved immediately began to increase.

While going through the harder cement blasting had to be done practically all along the face. The holes were placed 6 feet centres in rows 4 feet apart, and 2½ lb. rack-a-rock was fired in each, 5 feet below the water-line. The amount of the hard cement raised was only 2 cubic yards an hour, but in the softer 40 yards is now being raised, and it is expected that the dredger will manage 60 yards in the old ground, which extends (with soft bottom) for a chain to the east of the bar at the southern end, but widens towards the north.

The ground is understood to have been sampled, but for the directors' private information only, so that statistics of the contents are not available. It is said that in the original washdirt the tinstone was mixed with 10 per cent. of black sand. Now, in the old workings there are generally about equal proportions of the two minerals, though, owing to the Chinamen's sluicing, the proportion of black sand to tinstone is often as 5 to 1.

The Dredger.—The dredger was completed in June, 1902, but remained idle for twelve months, owing to the drought. It cost approximately £11,000.

The boiler is a 25-horsepower multitubular semi-loco. with enlarged grate; firewood now costs 11s. per cord, but in the late wet weather it rose to 16s. All the machinery is driven by a 20 nominal horsepower (140 indicated horse-power) condensing engine, with feed-water heater. There are 34 chrome-steel-lipped buckets of 4½ cubic feet capacity, the ladder allowing dredging to 25 feet depth. (*See* Plate 5.) Attached to one of the buckets is a pair of grabhooks for raising logs and boulders.

The material from the buckets is tipped on to a steel shoot, but, owing to the unavoidable clearance space between the buckets and the shoot, clayey and sticky material very often misses the shoot, and falling down the well fouls the bottom of the paddock. A second shoot was therefore installed below the main one, and a trial was made to see if it would pay to treat it in a long tom, but owing to the poverty of the ground ("cement") at the time, the experiment was a failure from a financial point of view. The material is

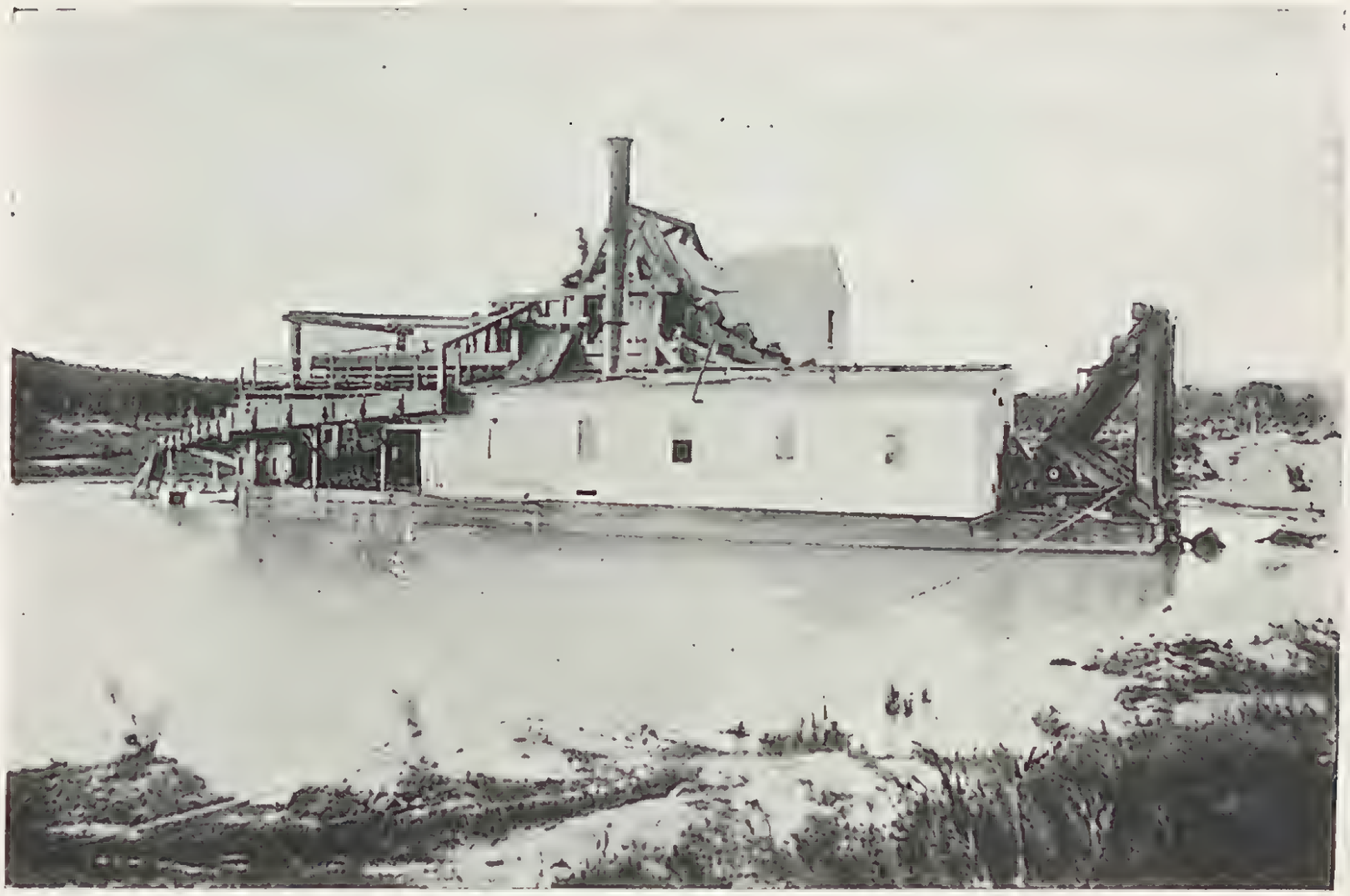


Photo., L.C.B. STANTHORPE PROPRIETARY DREDGER.

Plate 4.

Photo., L.C.B. STANTHORPE PROPRIETARY DREDGER, BOWS.

SHOWING METHOD OF SUSPENDING "LADDER."

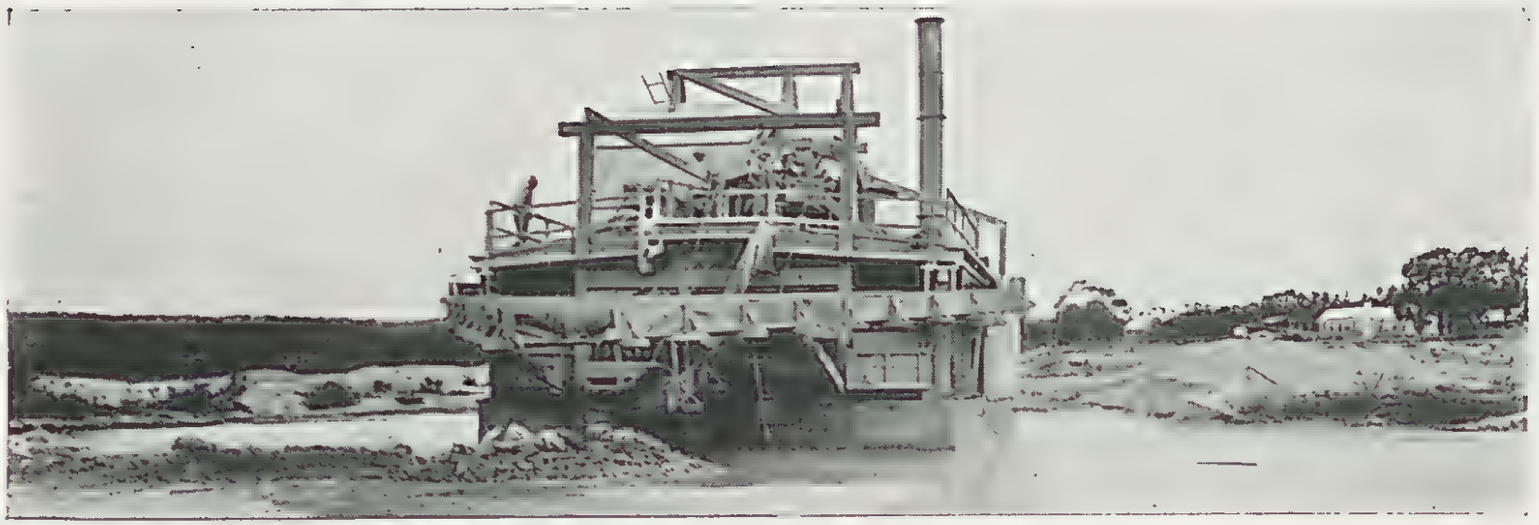


Photo., L.C.B.

STANTHORPE PROPRIETARY DREDGER, STERN.

SHOWING UPPER WORKS AND LAUNDERS FOR COARSE AND FINE TAILINGS.

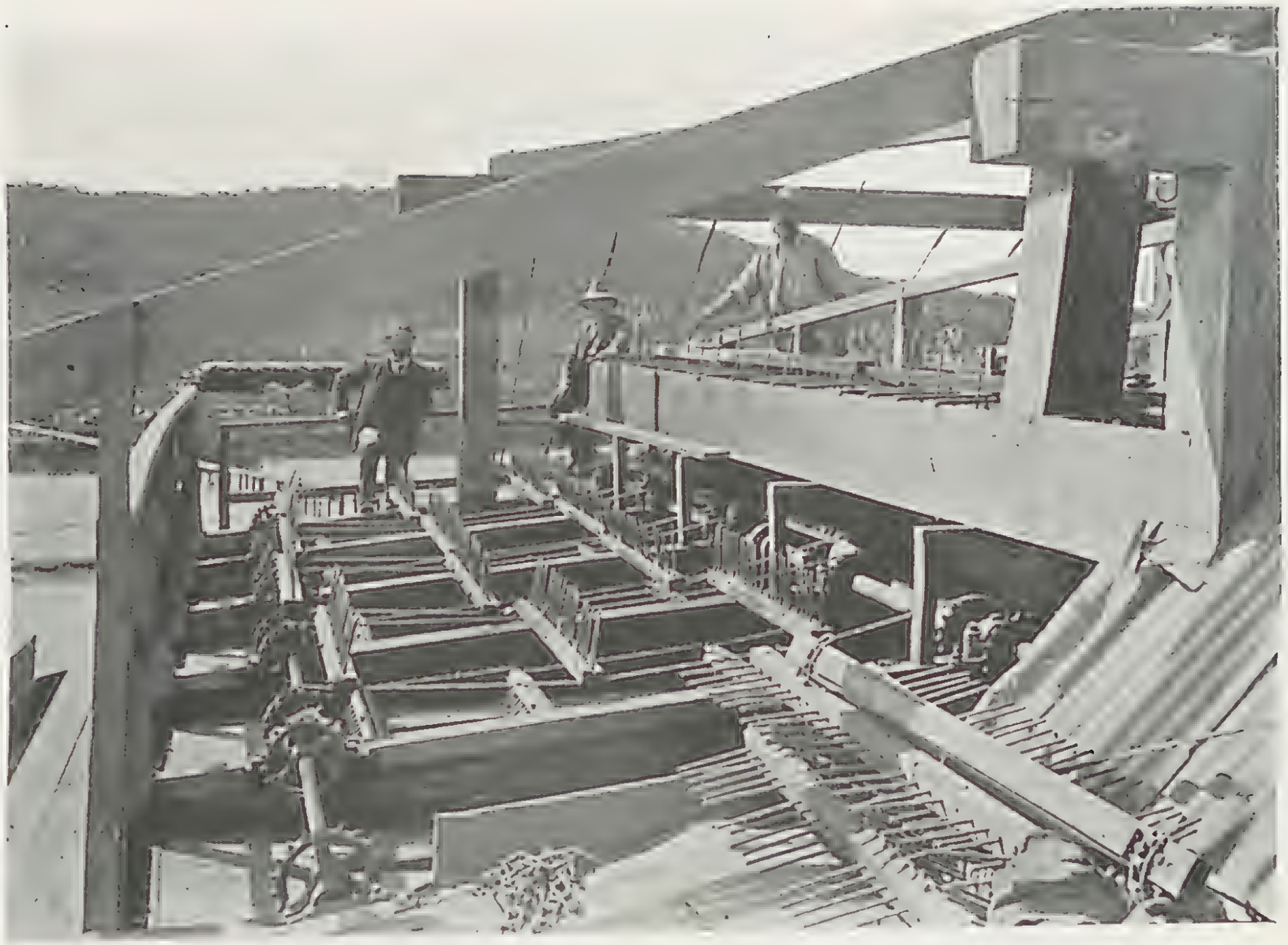


Photo., A. P. Corrie. STIRRING RAKES, STANTHORPE PROPRIETARY DREDGER.

Plate 7.

now, therefore, simply run out behind the dredger. From the upper shoot, where it is proposed to have a jet of water, the material is washed by a 12-inch stream of water from a 9,000-gallon pump over a grizzley with bars $\frac{3}{8}$ inch apart. This serves instead of a revolving trommel, the finer stanniferous wash falling through on to a central distributing table, 25 feet by 8 feet in area, while the coarser material, including many unbroken lumps of clayey wash, is swept down a launder and banked up astern of the dredger, preventing the fines from the sluice boxes, deposited beyond, settling under the dredger. (*See* Plate 6.)

From the distributing box the tin-bearing sands are washed on to five lateral tables (12 feet long, 5 feet wide, and falling $\frac{1}{2}$ inch in a foot) on each side. The sand is kept stirred in each of the tables by seven rakes, made of $\frac{1}{4}$-inch iron rods set $1\frac{1}{2}$ inches apart in a wooden bar attached to endless chains worked on toothed wheels. (*See* Plate 7.) Each lateral table is divided longitudinally into four compartments to prevent "guttering." The tendency is for most of the sand to enter the first tables and the water the last, and, therefore, launders with a valve for each compartment have been provided, so that water can be added when necessary. Most of the tinstone saved is within 5 or 6 feet of the top of the tables.

Only one shift has thus far been employed, consisting ordinarily of three men (engineman, fireman, and grizzley man), and two lads (one loading timber—enough for three shifts in one day—and the other on the long tom in connection with the lower drop shoot).

The total expenses, working three shifts and allowing for wear and tear of machinery, for firewood, and salaries, Mr. Martyn has calculated will be £170 per month. About $\frac{1}{2}$ ton of tin ore is now being saved a week (for 30 hours' work), so that, though not in the main ground, the dredge should be just paying expenses. On 3rd December 2 cwt. of cleaned tinstone was saved as the result of five hours' work.

Another of the difficulties here will be in connection with the water supply, but it is hoped that by pumping water from a hole in Quart-pot Creek into the Chinaman's race it will be possible for both ground sluicing and dredging to go on throughout the year. In fact, already a small quantity of water, for renewing that in the paddock, is being derived from the race.

Much of the ground to be dredged will be a flat terrace, slightly above the creek, so that the conditions are not so favourable as at Wylie Creek, for it will often be necessary to build a puddle wall at the lower end of the paddock. The immense boulders of undecomposed granite scattered through the wash, and the beds of hard "cement" so characteristic of the Stanthorpe district, will cause further trouble.

(*c*) Broadwater Proprietary Tin Dredging Company.

Locality.—This company has leases for about 2 miles along Broadwater Creek, 6 miles north of Stanthorpe ($8\frac{1}{2}$ miles by road). The prospecting bores, sixty in number, put down by the former holders, gave an average of 5 lb. of tinstone per cubic yard, to a depth of 9 feet over a width of 9 chains, for a distance of 110 chains; and an average of 3 lb. per yard, with 6 feet depth and 7 chains width, for a distance of 40 chains. They found the granite bottom soft, and reported finding not a single large boulder.*

Dredger.—The dredger was completed in 1901, and was worked at a loss for several weeks. During the floods in the latter part of 1903, the pontoon became partly submerged, and remained so till February of this year.

* Annual Report of William H. Rands, Government Geologist, for the year 1900.

The pontoon is 90 feet long by 30 feet broad, and 7 feet deep. One of Marshall's semi-loco. tubular "Dredger" boilers supplies steam for the winch engine (8-inch diameter and 6-inch stroke), for the main engines (double expansion 12-inch stroke, and 12 and 6 inch diameter) which are provided with feed water-heater and condenser, for the small Crompton engine working the electric light dynamo, and for the various pumps. Firewood is expected to cost not more than 8s. a cord.

The buckets, thirty in number, have a capacity of 4½ cubic feet, and are capable of raising 2 cubic yards of wash a minute.

The wash from the buckets was tipped on to a steel plate 6 feet long and 4 feet wide, and thence washed down by water from a four-valved tank onto a wooden sluice box, extending out to the stern. This is 7 feet wide at the top end, and 6 feet at the bottom, and has a length of 25 feet, with a fall of about 6 inches. A 4-inch slit near the bottom of the sluice allowed the heavy fines to drop through into a three-compartmented sluice (10 feet long, and falling 3 feet), running back towards the bows, and discharging into a pointed box, where upward current separation of the tinstone and sand was attempted. The coarser material in the sluice box was carried 15 feet beyond the stern in a launder 7 feet wide.

Ground.—The face worked was about 2 chains wide, and the dredger probably worked forward about 3 chains, but no tin seems to have been saved. The greater part of the wash turned over was fine sand with pebbles of crystallised (chiefly smoky) quartz, and it is considered that the old tailings average at least 1¼ lb. of tinstone per cubic yard. A little gold is sometimes found with the tin, and a prospector living in the vicinity showed me three small diamonds, a very light-coloured beryl (a crystal ½ inch long), and several topazes. The largest of the diamonds, a white, slightly pitted and encrusted hexakis-octahedron, was ½ carat in weight; the second, ¼ carat in weight, slightly off colour, had a roughly cubical form, but was covered with very numerous facets, and the third was a yellow fragment, ⅛ of a carat in weight. The wash is reported to have been from 10 to 14 feet deep, but the tin is known to have run in very narrow shoots, as the old workings show.

The average depth of dredgable ground over the whole property is taken as 9 feet. There is a clear width of 7 or 8 chains between the rocks, where the dredger is now, but some 5 chains below the dredger the rocks on opposite sides are only 3 or 4 chains apart, and a few chains above the dredger is a granite bar, above which the dredgable portion averages 5 chains in width, and extends for about 30 chains. For 40 chains below the flat where the dredger is now, the ground is undredgable, or else very poor, except for small patches a few chains broad and long, but further on is a 15-acre triangular area, 6 to 9 feet deep, which has been well turned over by the miner.

Working.—In order to work the ground on these leases dams will have to be constructed for a water supply, and the dredger will have to be floated over the rocky portions by building weirs. Luckily, the rocky part below the dredger has a very slight fall (25 feet in a mile), and only two weirs will be necessary there. It is difficult to understand why the dredger was erected in its present position—namely, in the centre of the lease— for it will be necessary now to work towards one end, and then to get at the ground at the opposite end the dredger will have either to be dismantled and re-erected, or else it will have to dredge its way back through its own tailings.

Mr. Martyn (the superintendent of the Stanthorpe Proprietary dredger) has lately taken charge of this dredger. He has pumped out the pontoon,

refloated it, and proposes to dismantle the whole of the tin-saving appliances, replacing them by an entirely different design. The cause of the failure of this dredger is put down entirely to the inefficiency of the tin-saving appliances.

(*d*) Sheehan's.

Mr. Rands, in his annual report for 1900, besides referring to the building of the Broadwater and Brisbane dredgers, mentions Sheehan's property on Broadwater, 4 miles slightly north of west of Stanthorpe. "Large amount of water. . . a series of waterholes. . . and only the shallow ground worked. . . Dredgable for 8 or 10 chains width and 14 to 16 feet depth. . . Conditions satisfactory, but no boreholes."

I heard when leaving Stanthorpe that a suction dredge had been brought from New South Wales and tried on Sheehan's, but that it had been a failure, had been dismantled, and was being removed to New South Wales again.

Mr. Sheehan has since forwarded me the following particulars:—70-horse-power multitubular loco-type steam boiler; No. 4 Knowles's duplex steam feed-pump; pair Morris Machine Company's vertical engines, direct coupled to a No. 8 sand pump, 8-inch delivery and suction, driven at about 300 revolutions per minute; capacity 30 yards of solids per hour. About 1,100 yards were taken out of the paddock, under great difficulties, owing to lack of water. Yield 1½ tons of tin ore—a little over 3 lb. to the yard. It was dismantled because capital not sufficient to construct a dam for conserving water, to purchase a break-down pump, and to obtain a proper set of boxes. Both washdirt and overburden are chiefly coarse sand and gravel.

(*e*) Prospecting on Four-mile Creek.

Locality.—Four-mile Creek rises on the border of Queensland and New South Wales, about 6 miles north-north-east of Stanthorpe, and flows in a general southerly direction to within 1½ miles of that town, when it bends to the south-east, and after several windings enters Quart-pot Creek. In its lower part it is known as Kettle Swamp and Law's Gully. Its fall is nowhere rapid, and its catchment area as a whole, especially near the creek itself, is flat. Machine Gully enters it from the east, about 3 miles north-east of Stanthorpe.

Tenure.—After most of the ground had been turned over by small claim holders, all likely ground was either selected or bought at auction, and is now freehold property. Thus, before operations can be started, arrangements have to be made with the owners, and it is generally conceded that the difficulty in coming to terms is one of the greatest drawbacks to alluvial mining in this district.

Messrs. Gibbs, Bright and Company some months since secured an option over the ground on Four-mile Creek from block 238 to 367 inclusive, a total length of 2 miles, of which probably only 1 mile will be dredgable. On the expiry of their option, being unable to obtain an extension, and their engineer (Mr. Hawley), having advised that the ground seemed worth prospecting, they decided to take a lease for fifteen years. This company is engaging on alluvial tin mining on a commercial base rather than a speculative one, finding that it is better to spend several hundred pounds on prospecting operations, and perchance prove the ground valueless, than to spend thousands installing costly machinery and then to make the same discovery or to find the material too poor to pay to work.

Prospecting.—Mr. Hawley, who is engineer in charge of operations, has been for several weeks surveying the ground to be prospected, and marking out the sites of the proposed bores. He himself took me over the leases, and has been good enough to give me the following particulars as to the work.

The method of prospecting employed here is that of 100 feet square intersections—lines of bores 100 feet apart being run along the creek and at right-angles to it. The ground between each four bores is assumed to contain the mean of the four results obtained. The average number of bores on each side of the creek is five (from three to seven), and there will be fifty-six rows along the creek, making, together with special bores (two rows on each side of Machine Gully), a total of about 600. It is believed that the average width will be 8 chains. The average depth of the ground to be dredged will be 7 to 8 feet.

Till lately only one boring plant was in operation, but a second was installed early in December, and in a short time a third was to be working, the three employing twelve to fifteen men for the following two months. By the end of January or the middle of February it was expected that sufficient information would have been collected for it to be decided whether the venture was worth going on with.

Each boring plant consists of a light derrick—three light timber legs with windlass attached—erected over the site of the bore for raising the boring apparatus, the lift amounting to about 20 feet. The only tools employed are a 5-inch auger (for surface work only), a $3\frac{3}{4}$-inch auger, a chisel, and an 18-inch pump for use inside the casing. These tools are attached to 1-inch square iron rods (made in 4-feet lengths), suspended from the derrick by a $\frac{1}{8}$-inch wire rope connected to the windlass. The borehole is lined with $\frac{1}{4}$-inch iron casing, 4 inches in internal diameter, made in 4-feet lengths, with flush joints.

Four men are employed at each bore, one winchman, two sinkers—*i.e.*, men to remove and replace the tools and to give the augers the necessary turning movement while sinking—and one washer (who "pans off" the wash-dirt).

All the material raised is carefully transferred to a cubical box with 12-inch sides, the water is decanted, and the material is stamped down firmly and the height in the box measured. The contents are then calculated with the aid of a table, and checked by the calculated contents of the bore, the measured exceeding the calculated by an average of 5 per cent., owing to the washing in of the material round the bore hole. The whole is then carefully panned off, and the concentrates cleaned to an average of 74 per cent. tin, weighed to the nearest grain, and then from a table the amount of tin ore per cubic yard is found to within an estimated 2 per cent. of the actual contents.

The average rate per day is three to four bores (9 feet 6 inches deep) per plant. Exceptional depths of 22 and 23 feet are reached, but greater depths than 15 feet are seldom found. During the last fortnight (end November and beginning December) eighty-three bores had been put down with two plants (during part of the time), and sixty a week were expected with three plants in operation.

By the time prospecting operations have been finished here, £1,500 or £1,600 will have been expended, of which £750 or £1,000 will have been on boring alone—the average cost per foot here being 1s. 6d.

The Ground.—It is proposed to dredge only about $1\frac{1}{2}$ mile of the lease—*i.e.*, from the centre of selection 253 to 259. The lowest part of the lease has

Photo., L.C.B.

PROSPECTING BORING PLANT, 4-MILE CREEK, STANTHORPE.

Showing Auger, Pump, Cubical Contents Boxes, Etc.

been well turned over, but is separated by many chains of rocky ground from the main portion, and will therefore not be dredged. The richest part of the lease is about the mouth of Machine Gully, and from there it is intended to work Four-mile Creek down for half a mile and up for one mile, and Machine Gully up for half a mile. The ground has thus far proved very patchy, several parts being rich enough to pay for ground sluicing, while others are too poor for dredging. The few prospects I saw from the bores consisted in great part of "rosin" and ruby tinstone, free from black sand. The tailings distributed over most of the flat are said to contain from ½ to 1½ oz. of tinstone to the dish. The overburden has been proved to be practically barren of tinstone, and some method will be devised for getting rid of it without passing it through the tin-saving apparatus. The bedrock in the deeper dredgable parts is soft decomposed granite, which generally hardens as the rock approaches the surface up the sides, while the tinstone contents at the same time increase in coarseness. The slope on the western side is believed to be valueless for dredging, being poor and shallow.

Mr. Hawley informed me that from one of the first bores a pale straw-coloured diamond, of the size of a pea, was obtained.

The original owners of the land sank 260 bores on the 2 miles of the claim, but not in any sequence, and without including the 3 feet of surface material in their calculations; and, in consequence, an exaggerated idea of the amount of tinstone in the ground was formed.

Dredgers.—Owing to the general scarcity of water in this locality, it is not unlikely that a large dredger would be laid up during three or four months in a year, and Mr. Hawley will propose, if dredging is to be carried on, to install several small suction dredgers, worked by motors from one central electrical power station. The three great obstacles to dredging—want of water, layers of "cement," and huge boulders—would be thus to some extent overcome. One of the chief reasons for preferring the suction dredger is that the bedrock will be exposed to view, and, if decomposed, will not be broken into as it might if a bucket dredger did the work. The ground on the shallower slopes not to be reached by the dredger will be sluiced down with nozzles to within reach of the suction pipes. In addition, the smaller plants will be more mobile, and less time will be wasted in repairs. However, it will not be actually decided to install dredgers until the results of the bores have been obtained, though I think these have been, on the whole, favourable.

IV.—LODE TIN MINING.

Mr. Skertchley in his report* on the Stanthorpe district, says, p. 42:—

"I. The stream tin is not derived from lodes, but from two distinct sources of probably contemporaneous origin: (*a*) the greisen, or altered granite of the joint planes; (*b*) the dykes, chiefly elvan. . . . 3. The whole of the greisen and much of the elvan is, by constant weathering, releasing tin and forming what is known as surface tin. . . . quite crystalline and unworn. 7. The richness of the stream tin is no proof whatever, or even an indication, of the existence of rich lodes; but was due to the long-continued denudation of very widespread though poor stanniferous rock." With all this I am in entire agreement, except that it is quite possible, though perhaps not probable, that payable stanniferous lodes may yet be found.

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* *Op. cit.*

(*a*) The Ballandean Tin Mining Company.

The Ballandean Tin Mining Company has secured a lease from the owner of a 500-acre unconditional selection on the left bank of the Severn River, 6 miles west of Ballandean Railway Station, with the intention of testing several adjacent veinlets of tin ore outcropping on a ridge-top there.

The country rock is clay-slate which, along the joints striking about north-north-east to north-east, and dipping west-north-west, has been greisenised, and there carries bunches of large crystals of tinstone ($\frac{1}{2}$-inch diameter). These micaceous joints are found over a width of 107 feet on the surface, the total amount of tin present being only a fraction of a unit per cent. The hope was reasonable that a payable patch of tin ore might be found at a greater depth, and, therefore, an adit was opened from the west at about 40 feet below the hilltop, but though the main joints were found at 26, 44, and 61 feet to be mineralised with mispickel, they contain scarcely any tinstone. A drive is being opened to the south on the last mentioned joint, where there is 6 to 9 inches of quartz, besides 2 feet of cupriferous mispickel, which practically cuts out on the opposite side of the adit. The adit has been carried in a total of 81 feet. A small granite vein in the face points to the main granite mass being at no great depth. I can see no promise of a permanent lode being found here, but it might be some satisfaction to sink on the third vein to a depth of, say, 50 feet, as a bunch of rich ore might be found.

Rich stanniferous and mispickel-bearing veins (similar to those at Red Rock), on north-east joints are to be seen in the granite below the slates on the southern side of the Severn River, half a mile north-west of this adit. Several hundredweight of ore (50 per cent. tinstone) was obtained from one of these, and more could be got, but permanency is not to be expected. Several prospecting trenches were opened in the locality a few months ago, one of which exposes greisen carrying a little molybdenite and tinstone, but in too small quantities to be worth holding.

(*b*) Late Prospecting at Red Rock.

During the last month (November) two claims have been pegged out about a mile east-north-east of the Sundown Mine, on one of the branch gullies opening into Red Rock Creek. They are near the centre of an area formerly held under mining lease.

Mr. Skertchley refers to the granite boss of Red Rock as being euritic, with north-north-west master joints. Mr. Rands visited the locality in 1883, and found a shaft and trenches, reported to be on a 20-inch quartz reef, with strings of ore.

P. A. 49 (Morris Claim).—This, which is on the eastern side of the old M. L. 814, is reached after a stiff climb of over 550 feet down from the Sundown road. The country on the south is slate, but there is a gradual passage down the hill to the granite below. The Sundown Mine (in slate) is 1,200 feet below the range top, but the junction of the slate and granite here is only 750 feet below it, the granite having intruded further in to the slates here.

Morris has begun a shaft in altered slates containing mica, copper stains, and finely-disseminated tinstone, but as yet the formation is not well-defined, and enough work has not been done for its value to be determined.

About a chain to the north and 70 feet below is an old shaft on, to judge by the tip, felspar rock, containing crystals of tinstone up to $\frac{1}{3}$-inch in diameter,

with veins of crystallised quartz. Some 50 yards below the shaft is an old open cut, the result of a company's work two or three years ago. The country here is still slate, the ore, bunches of tin-bearing quartz and soft replaced slate, occurring on joints. The company burnt and dollied the ore, which, to judge from what they left, must have been very rich.

P. A. 51 (Gunn's and Eli's Claim).—This adjoins P. A. 49 on the north, and is wholly in granite—very siliceous and felspathic, with joints striking north-east to east-north-east, and dipping south-east. At the north-eastern end of the tried ground is a trench 10 feet long and 2 feet deep, on a 6-inch vein of almost pure cassiterite, with a little soft matrix, in a joint in granular quartzose granite. Towards the south-west several small veins, carrying tinstone, have been exposed over a width of 5 feet, and the ore has been traced for 3 chains to the south-west. A shaft in slates on the ridge, a quarter of a mile beyond, is believed to be on the same line, though the tinstone has not been found beyond the granite. The prospectors wish to have a battery erected at once, but it would be much wiser for a small company to thoroughly test the ground by trenches and shallow shafts and crosscuts. The amount of work yet done is quite insufficient to show the nature of the deposits. The largest trench rather points to the main vein of ore pinching within a couple of feet of the surface. I am inclined to believe that the tinstone has, near the surface, been somewhat concentrated, not only mechanically but chemically. If the zone 5 feet wide is proved to carry 5 per cent. of tinstone, there should be no doubt as to the advisability of erecting a battery. A certain amount of difficulty will be experienced in reaching the main road, owing to a climb of over 1,000 feet within half a mile, but an entirely new road could be made, at some expense, round to the Red Rock Creek Crossing.

The other old workings in this locality were not seen.

2.—Notes on Copper and Silver Mines near Stanthorpe.

I.—SUNDOWN COPPER MINE.

Locality.—This is a reward copper claim—the old M. L. 24, the only one in existence of twenty-eight mining leases at one time held in the country between Red Rock and Sundown Creeks. It is on a branch gully from Sundown Creek, 3 miles above the Severn River and 28 miles south-west of Stanthorpe. The hills over which the Stanthorpe road passes rise 1,200 feet above the mine, within a distance of a mile, so that there was a great difficulty in making the road in the first place, and in using it in the second. It is proposed, in the event of operations being again begun, to construct an aerial tramway to do away with the necessity for the road for most purposes.

The only workings in existence at the time of Mr. Skertchley's visit* were on the opposite side of the creek (Clare's open cut). The last work was done in December, 1900, at which time £5,875 had been expended. The present holders are endeavouring to raise capital to prove the lode.

General Surface.—From the mine a tramline ran down to the reverberatory smelter, 7 chains distant. This put through 70 tons a week, the last smelting of 150 tons taking 16 days. The only building now standing besides the furnace-shed is the assay office.

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* *See* G.S.Q. Publication, 120.

Firewood was swung on wire ropes across to the furnace from the adjacent hills and ridges, it being impossible for vehicles to negotiate the country.

There is no natural permanent water supply here, the gullies being deep and narrow but short and steep, allowing the rain water falling in them to quickly run off. It would be possible to conserve a sufficient supply by one or more small dams.

Mine Workings.—The mine workings include an adit 270 feet in length along the lode—*i.e.*, to the north-east and east-north-east, about 50 feet above the bottom of the valley, and 70 feet below the ridge top. Half way in a 60-feet shaft connects with the surface, and at 100, 135, and 250 feet from the mouth are winzes 15, 50, and 26 feet deep respectively. At the bottom of the second winze drives 30 and 53 feet in length, south and north, have been opened, and are reported to be in ore. There is said to be 4 feet of ore in the bottom of the third winze. These are now all inaccessible, the main one being flooded.

An overhand stope extends from the mouth of the adit to within 50 feet of the end (where the lode is 3 feet 6 inches wide, with a 9-inch cherty centre) for from 20 to 10 feet above the drive.

The adit seems to have been opened in slate, but at 15 feet from the mouth grey arsenical material, 2 feet in width, begins, and continues for 5 feet, beyond which the stopes begin.

The ore is, as a rule, not easily separated from the country—gradually passing into it—but there are well-defined walls, within a few inches or a few feet of the lode. The lode increases in thickness from 2 feet near the mouth of the adit to 5 feet at the second (main) winze, then decreases to 3 feet, but again, at the third winze, spreads out to 7 feet width, including much country. It seems to have split up then, and one of the branches has been followed, and is widening in the face, where it contains (Government Analyst):—

Gold	...	...	16 gr. per ton
Silver	...	...	16 oz. ,,
Copper	...	...	11·8 per cent.

The main branch is probably to the east-south-east of the end of the adit. The lode is made up of lenticular bunches, as may be especially well seen at the top of the stopes near the shaft. Great and sudden variations in thickness sometimes take place within a few inches, owing to the occurrence of flat floors or flaws, and the ore extending further on one side than the other. The ore consists in greater part of mispickel, but with considerable quantities of chalcopyrite and quartz, and a little cassiterite.

In 1899, 30 tons of ore were sent to Cockle Creek, and ran 11½ per cent. copper, with silver and gold in addition. The last smelting (150 tons of ore) made locally, produced 25 tons of matte containing 29 per cent. copper, with 76 oz. silver and 6 dwt. gold per ton, showing that the ore averaged 4.83 per cent. copper, 12 oz. 13 dwt. silver per ton, and 1 dwt. gold per ton.

Geology.—The country rock is a highly altered, fine-grained sedimentary, the true bedding of which is not distinguishable, owing to metamorphism the secondary jointing. Granite is reported to occur on Mount McDonnell, 2 miles south-west of the mine, and on Mr. Skertchley's map a small patch is shown on the Severn River, just above the entrance of Sundown Creek. Their occurrence, together with that of the Red Rock boss, go to prove that the whole of the area is underlaid at no great distance by granite, though the mineralogical nature of the lodes would alone suffice to indicate that. It seems plain that

the minerals have been given off by the cooling intrusive granite, and precipitated in fissures and joints in the sedimentaries above. The ore deposits at Sundown all lie on one zone, but probably in separate fissures. It is quite possible, considering the small deposits of staniferous ores in the vicinity, that in the Sundown lode the amount of copper will decrease at a depth, and the tin increase. It is also most likely that there will be rich ore at the junction of the slates and granite.

II.—WORKINGS IN THE VICINITY OF THE SUNDOWN MINE.

Clare's Open Cut (the Great Eastern or Tin Mine), is 10 chains south-west across the gully from the mouth of the adit, and is included in M. L. 24. The tinstone is chiefly in joints in the slates, but where the rock is greisenised the mineral occurs throughout it, often included in mispickel which has replaced the slate; 20 tons of tinstone are said to have been obtained by dollying and sluicing a formation 7 feet wide.

A shaft was sunk in the bottom of the open cut, but has been filled in again. From the knowledge that the tinstone came from the granite below one would expect to find other deposits in depth, though prospecting for them might not be a payable venture. Wolfram was reported to have been almost as plentiful as tinstone, though little is now to be seen.

Beacroft's.—On the hillside, 330 feet above, and nearly half a mile south-west of the Sundown adit, are old workings on M. L. 23—trenches and potholes on the ridge-top, and shaft and open cut on the north-eastern slope. In the trenches vertical joints in slate are seen striking north-east, and along them lie bunches of mispickel carrying small crystals of tinstone. The main shaft is 30 feet below, and a chain north-east of the trenches; it is said to be 100 feet deep, but is now inaccessible. The mispickel ore obtained, together with a little pyrite and cupriferous pyrite, at a depth, carried small quantities of tinstone. The country is slate.

An open cut 10 yards to the north-east and 30 feet below the brace of the shaft simply shows, in much-jointed and impregnated slates, a zone 4 feet wide of stained and decomposed country with stanniferous mispickel ore in bunches up to 2 feet in diameter. The ore in the decomposed surface portion was washed in a cradle, to separate the tinstone.

An adit was begun 35 feet below, on a formation with slightly more tinstone than in the open cut, indicating a more promising state of things as the granite is approached. No copper carbonate is to be seen, but abundant scorodite (hydrous arsenate of iron).

About 10 chains north-east of the Sundown adit on the north-eastern side of the same ridge, arsenopyrite in slate has been trenched on, but little of promise can now be seen. A small open cut, 10 chains further up the ridge to the east-north-east, shows an interesting occurrence of pyrite, arsenopyrite, blende, cassiterite, hornblende, &c., in slate, proving the granite is at no great depth. Owing to the water in the open cut, the whole ore body could not be seen, but Mr. Skertchley gives its greatest width as 3 feet.

III.—SILVER QUEEN SILVER MINE.

The mineral lease (No. 72), of 40 acres, lies on the right bank of the Severn River, a little over 6 miles west of Ballandean Railway Station, and a mile west of the tin-sluicers' claims. It was secured in the beginning of 1899, and worked with sixteen men for two years, during which time £3,000 was spent on mining and road-making.

Workings.—Five shafts have been sunk along the line of lode. The main, or "prospecting" shaft (No. 5), is on the ridge-top, 50 feet above the river, and its total depth is 100 feet. At 35 feet depth is a level to the north-east for 10 feet, in slightly copper-stained strongly pyritous decomposed saccharoidal siliceous country, and another to the south-east for 6 feet in highly altered slightly copper-stained country. Ore is reported to have crossed the shaft between the 35 and 60-feet levels.

At 60 feet depth is a crosscut to the west for 10 feet to a winze on the lode, which here has a width of from 12 to 20 feet. This winze was also sunk to the 100-feet level, but, like the main shaft, it is now flooded below the 60-feet level.

Mr. Rodda, the former manager, has informed me that at the 100-feet level is a 30-feet crosscut to the west; and a drive, 100 feet in length, proves a shoot of ore 60 feet long. At the western end of the drive is a crosscut proved 20 feet of ore. The ore body in the No. 4 shaft at the surface was believed to have been cut by the eastern drive. A crosscut to the north reached slate in 40 feet.

About 500 tons of ore lie at grass, and rather more mullock. A sample of the ore assays (Government Analyst):—

Gold	... ...	16 gr. per ton
Silver	... ...	17 oz. 12 dwt. 0 gr. „
Copper	... ...	1·26 per cent.
Lead	... ...	7·0 „
Zinc	... ...	8·8 „

A trench to the west exposes fine-grained quartz-felspar-porphyry, but no ore. The ore has, however, been followed to the east to the river. The first shaft (No. 4), an underlie 70 feet deep, is 1 chain east of the main shaft; in it, or in the 17-feet crosscut on the south, at 50 feet depth, a little poor mispickel was found. The second (No. 3), 1 chain further east, is on pyritous stone, believed to be a formation. There is a big outcrop of decomposed porphyry, stained with copper carbonates, about a chain beyond, and an open cut, 10 yards across and 10 feet deep, with shallow shafts partly filled in. The ore raised here (about 10 tons of siliceous mispickel) does not look very promising. In the last shaft, half a chain beyond, only traces of ore were found. The river is only 30 feet below this.

Output.—Forty tons of picked ore have been sent to Cockle Creek, in different parcels, yielding from 2½ to 4½ per cent. copper, 15 per cent. lead, and 8½ to 16 oz. silver (average 12 oz.), the siliceous ore being richer in silver.

Geology.—These deposits consist of impregnations and replacements of the northern parts of a quartz-felspar-porphyry dyke (which is of extremely variable coarseness), the replacing minerals consisting chiefly of pyrite, with galena, chalcopyrite, and a little arsenopyrite, zincblende, &c., the last filling interspaces between the quartz crystals. The ore is bunchy, and, though the bunches may contain large quantities, work will be expensive. The value of the ore is stated to be about £4 a ton.

The presence of the blende is rather unfortunate, for the amount would be largely increased by concentration, though perhaps not to the extent of preventing the smelting of the concentrate. It is, however, possible that if the percentage proved very high the concentrates could be shipped to an oil-concentrating works, where there should be no difficulty in separating the minerals. Certain of the wet processes for copper extraction, such as Neill's or Van Arsdale's, or the new Hunt and Douglas, are as likely as any to enable this ore to be profitably treated.

Plate 9.

Photo., L.C.B.

GENERAL SURFACE VIEW, SILVER SPUR.

Showing Winding-house, Poppet Legs, Roast Heaps, and New and Old Reverberatory Furnace Sheds.

IV.—PIKEDALE SILVER MINE.

The Pikedale Silver Mine is on freehold block 802, near Pikedale Head Station, and within a few chains of the Silver Spur road, 20 miles west of Stanthorpe.

The mine is not now being worked, but was visited by Mr. Skertchley in 1897, a year before it closed.* There were then six shafts, the deepest 84 feet (now 170 feet) deep. Mr. Skertchley gives the thickness of the lode as from 1 to 3 feet. The ore contains silver, gold, copper, lead, zinc, iron, manganese, &c., but, unfortunately, no analyses have been published. A furnace was erected on the ground, and the matte produced shipped to Europe. Mr. W. G. Rodda, late manager of the mine, tells me that he smelted 750 tons of ore, producing 100 tons of matte, containing 30 to 40 per cent. copper, 150 to 300 oz. per ton silver, and ½ oz. per ton gold, valued at £3,000 in Swansea. This gives the contents of the ore as:—

Copper	...	...	4 to 5½ per cent.
Silver ...	...	...	20 to 40 oz. per ton
Gold ...	...	...	1 dwt. 8 gr. per ton

Mr. Rodda affirms that the lode averages 6 feet in width, and contains from 2½ to 5½ per cent. copper, and from 16 to 40 oz. (average 25 oz.) per ton silver.

The refractory nature of the ore seems to have caused some trouble, but the large amount of non-contributing shares are held to be the chief cause of the mine's present idleness.

3.—Notes on Mines near Texas (Stanthorpe District.)

1.—SILVER SPUR SILVER MINE.

(*a*) Locality.

Silver Spur lies west-south-west of Stanthorpe, 44 miles in a direct line, and 53½ miles by road. It is 6 miles east of Texas, and 3½ miles from the Severn or Dumaresque River. The main Stanthorpe road runs *viâ* Texas, and is 20 miles longer than the direct short cut from the mine, which the mail coach, running twice a week, now takes. Silver Spur township has a population of something over 200, depending absolutely on the mine, which it now practically encircles.

(*b*) History.

The discovery of copper-stained gossan was made in 1891 by one of the men employed at the Texas Copper Mine. A syndicate was formed, and sunk a prospecting shaft (No. 1) to 70 feet depth, for copper. Soon after the mine was "jumped" and held as a silver mine, the first specimen assayed yielding silver equivalent to 216 oz. silver per ton, the richest yet found. In November, 1892, the mine was purchased, a small company (24,000 shares of £1, paid up to 15s.), was formed, and has successfully carried on operations till the present, when prospects are brighter than at any previous time.

The mine is referred to at some length in Mr. Skertchley's report on the Stanthorpe district, already quoted,* and in an interesting paper by Mr. H. G. Stokes, read before the North of England Institute of Mining and Mechanical Engineers.

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* G.S.Q. Publication, No. 120.

(*c*) Mining.

This mine is unique in Queensland, the deposits worked consiting of huge partly isolated leases. A relatively large amount of dead work is necessitated in exploitation, for though a shaft is sunk on each deposit, it has to be connected with the others for ventilation, exploration, and exploitation, making the total expenses of mining unusually great. The mining costs for the year 1901, exclusive of shaft-sinking and prospecting, were 16s. per ton, the work in the larger stopes costing 7s., and in the smaller 15s.

About thirty men are employed in connection with mining alone, half on the surface and half below, but a far greater number are engaged in wood-cutting, and timber, lime and matte carrying.

Comparatively small shafts (3 by 6 or 9 feet), have thus far been sunk, but the main shaft, now a little over 300 feet deep, in which most of the hauling is done, from between the 200 and 300 feet levels, where the No. 2 and No. 3 ore bodies and those below are being worked, is now being enlarged.

The levels are large, and need very little timber, but in the larger abandoned stopes passages have to be kept open by means of square set timbering. No timbering whatever is required while working in the sulphides.

The importance of prospecting is well understood at this mine, for in several instances new ore bodies have been found by breaking into the country adjacent to the workings; yet, at the present time very little exploratory work is going on. In fact, the main shaft is only a few feet below the 300-feet level, and this is especially surprising in view of the fact that an up-to-date reverberatory furnace is now in course of erection.

(*d*) Output.

The anual output of ore is about 4,000 tons, but a steady increase is now expected. At the end of last year (1903), there were 2,000 tons of ore on the surface. The amount actually smelted in 1903 amounted to 3,802 tons, yielding:—

Silver—96,000 oz.	valued at	£8,967
Lead—45 tons	„	517
Copper—31 tons	„	1,798
Gold—147 oz.	„	588
		£11,870

The total dividends to the present amount to £18,618.

(*e*) Surface Plant.

The winding is done by a 12-horsepower engine, geared to a 4-feet drum, and supplied with steam by a 52-horsepower Babcock and Wilcox boiler. In the same building is a Westinghouse Standard 12-horsepower engine and air compressor, delivering air at 70 lb. pressure to the two rock drills used in the mine. Adjacent to the engine-house is a small sawmill, which has been found necessary, owing to the isolated position of the mine, and has, besides, proved of considerable service to selectors in the district. Near the shaft is a "Giant" crusher, with 9 by 15 inch jaws, worked by its own 10-horsepower engine, and used for crushing the lime and quartz or siliceous ore from the mine used in smelting, the latter when the ore becomes too basic for the furnace—*i.e.*, when the silica contents fall below 20 per cent.

Photo., L.C.B.

SURFACE PLANT, SILVER SPUR.

Showing Old Whim, Engine-house, No. 4 Shaft Poppet Legs, Main Shaft Poppet Legs, Rock Crusher, and Grizzleys.

(*f*) Geology.

The ore bodies occur in beds of dark-grey clay slates, which are interbedded with lighter clay slates, and the occurrence is due to strike faulting or crushing. Sandstones, conglomerates, and limestones, as well as schists and quartzites, occur in other parts of the district, and in some of the sandstones Permo-Carboniferous fossils have been found.* The average strike is north and south, with variable easterly dip. Numerous diorite dykes have been noted, one outcropping within 10 chains of the ore bodies. It is most probable that the ore-bearing solutions were derived from the deep-seated mass of which this dyke is an offshoot.

It has always been recognised that the Silver Spur ore bodies are closely connected with faults. At first it was thought that they were simply bunches attached to one main fault, striking about north-west. This fault is most strongly, or at least most plainly, developed at the north-western end, but towards the south-east it has split up into several nearly parallel branches, and it is difficult to say which is the main one, especially near the main shaft on the 200 and 300 feet levels, where the faults include ore bodies.

Several other faults abut against this main fissure on the south-west, generally normally. These are "strike faults" (the country having a strike of about north-north-east), and along them the country has been replaced by ore, the result being ore bodies. As a general rule the ore bodies are not adjacent to the main fissure in the upper levels, but approach it in depth, and seem there to be developing along it as well as on the fissures at right angles to it.

The main fissure (first found at 45 feet depth in No. 2 shaft), is tight, and never carries water, while the gossans and ore fissures are always saturated when first opened; it is strongly graphitic in places, especially in the central part of the workings and on the 300-feet level. At several places along the fault the country on the southern side is seen to be bent round to the west, near the fault, and therefore the country on the south has been shifted to the south-east, but it is not possible to give the amount of movement, either vertical or horizontal. The main fault was driven on to the south-east from the No. 2 shaft at 60 feet depth, and found to split at 50 feet distance. The country is crushed towards the end of the drive, and work stopped at a strongly mineralised promising-looking "floor," but a drive from the Long Drop shaft to the east is believed to be only 30 feet distant, and proved only a barren fissure.

It was the idea of Mr. Stokes, the former manager, that the fault splits at the 180-feet level, and that the deposits are included between the branches below; the present manager believes that the lower faults do not junction at the 180-feet level, but extend as parallel planes to the surface. There is nothing to support the latter hypothesis. This splitting of the faults has caused considerable uncertainty as to their relations to the ore bodies on the 150 and 300 feet levels, owing to some of them cutting across the bodies.

Ore.—The ore consists of a fine-grained crystalline mixture of galena and blende, with patches and bands of chalcopyrite and pyrite. That the ore has replaced country rock either where thin bedded or crushed (or in other places brecciated), is proved by a section in the drive along the main fault at the 200-feet level, where 2 feet of fissile ore occurs, identical in appearance with the adjacent country.

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* "Ore Deposits of Silver Spur." By H. G. Stokes, Proc. North of England Inst. of Min. and Mech. Engineers. 1899.

Formerly all quartz and quartzose ore were rejected, but the siliceous ore now being got—especially on the 300-feet level, where it contains ruby silver ore (silver sulphantimonide)—is richer than the clean sulphides, and the manager hopes to be able to work out much ore formerly left.

A granite pebble (white quartz, black biotite, pink felspar, and pinite) 3 inches in diameter, was found last year in the ore between the 200 and 300 feet levels in No. 3 ore body. While many of the pebbles found in the slates are due to movement and represent uncrushed country, these granite pebbles, of which several others have been found in the district, have been dropped from floating trees or ice, during the deposition of the sediments.

As the gossan was gradually worked out it was found necessary to work the sulphides, and some surprise was caused by their relatively high silver contents. (*See* analyses below.)

(*g*) Ore Bodies.

It was believed till lately that there were four main deposits, but the work on the 300-feet level has brought to light several additional deposits between No. 2 and No. 3 shafts. One of these bodies is the largest yet found, so the management have good cause to think that there is a bright future before the mine.

Ore Body No. 1.—The prospecting shaft, which is 150 feet deep, was begun on a small outcrop of copper-stained gossan, containing a little native silver. It is vertical to 60 feet, and then underlies steeply to the east to the bottom.

The ore body has now been practically worked out, though there are signs of it again at the 300-feet level. The gossan on the 60-feet level was worked for a distance of 130 feet north and south, with a width of from 5 to 25 feet, strings of ore still running on to the south beyond where worked, apparently well worth prospecting. The average value of the gossan was:—

Silver	...	...	30 oz. per ton
Gold	...	...	20 gr „
Copper	...	...	2·5 per cent.
Lead	...	...	5 to 6 „

but assays up to 6 oz. of gold per ton were obtained. The gossan passed into sulphide at 90 feet depth.

At the 100-feet level the average width was 10 feet, and small lenses of ore can here be seen on the eastern side of the face, replacing the clay slate country, while the western wall is slickensided and slightly graphitic. The hanging-wall is generally broken and mixed with ore. A tongue 8 feet wide, of 22-oz. ore, still remains at the south end, and will be worked in the future; 12 feet width of poorer ore (12-oz.) have also been left at the northern end, though it may improve within a foot. A block between the 80-feet and 100-feet levels is the only quantity of ore left in the No. 1 workings. A prospecting drive, known as "Hall's Folly," was carried 100 feet to the north-north-east of the main fault, at the northern extremity of this ore body, in unsuccessful search of other bodies. Much broken country, carrying an ounce of silver per ton, similar in appearance to the highly argentiferous country beside No. 4 body, was met 30 feet north of the fault.

At the 150-feet level the ore was worked over a length of 85 feet and a width of from 1 to 20 feet, but for only 20 feet below the level where it showed signs of "tonguing out." The body was thought to have pinched out here, but miners believe the small body on the 300-feet level is the same. The ore

is here broken up by floors dipping south-west, and similar in their occurrence to those in the country north of the main shaft. The sulphides from this body averaged:—

Silver	16 oz. per ton
Gold	1 dwt. „
Silica	26·25 per cent.
Sulphur	27·83 „
Iron	24·57 „
Zinc	11·40 „
Lead	6·46 „
Copper	2·20 „
Manganese dioxide	1·19 „
	100·00

The ore is composed of dense galena and blende with patches and bands of pyrite and chalcopyrite. A slight amount of poor quartzose gossany ore is now being got from the No. 1 body, for fetling purposes in the reverberatory furnace. A few small bunches of ore occur along the main fault between No. 1 and No. 2 ore bodies.

A strange body of ore came in at 170 feet depth, within a few feet of the No. 1 lode, and was followed up from the 200-feet level, on the northern side of the fault cutting off No. 1.

On the 200-feet level, 50 feet north-north-west of No. 2 shaft, a strong formation on a good fissure striking north-north-east has been taken to be the No. 1 body, but in the face of a drive running north-west from the shaft there is now a strong emission of carbon dioxide gas. No. 1 body having been "leady" and gaseous. it is expected that it will be found by continuing the drive.

Ore Body No. 2.—No. 2 shaft, 100 feet east by south of No. 1 shaft, was begun with the idea of striking the No. 1 ore body at a depth, and unexpectedly struck the No. 2 body, which did not actually reach the surface, though afterwards worked to within a few feet of it. It is now 317 feet deep, and used as a main hauling shaft, because of its central position; its dimensions above the 200-feet level are 9 by 3 feet, but below that 11 by 4 feet, the intention being to strip down the upper part when opportunity occurs.

The body near the surface had a length of 65 feet with an average width of 5 feet, while on the 56-feet level it had a total length of 110 feet, with a width of 2 to 10 feet. The southern half was gossan to 80 feet depth, the northern to only 45 feet, the two parts being supposed to be separated by the main fault. The oxidised condition of the southern portion is probably due to the slightly crushed nature of the country there. The slate pebbles found in the ore here may possibly be the harder uncrushed parts of the original country. The sudden variations in the size of the ore bodies is strongly marked on this level, where the ore suddenly increases from 1 or 2 feet to 6 feet in thickness at one of the "floors."

On the 100-feet level the body abuts against the fault, and averages 6 feet in width for 60 feet from the shaft, beyond which the drive was continued 15 feet further south, on formation, with occasional bunches of ore in clay slate. The crushed country to the east carries a little silver. The ore near the shaft is fissile, and the laminæ run in to the south-west (elsewhere they bend to the south-east), and, therefore, there is reason in believing the main fault is not here, but further north. On the southern side of the shaft small lenses have been followed for 100 feet, which, when bearing ruby silver ore, often

contain over 40 oz. silver per ton. The numerous lenses, the formation on the fissure, and the black shaley nature of the country, all indicate the presence of another ore body here. A winze sunk to the 150-feet level proved several overlapping lenses.

The No. 2 ore body was not worked below 130 feet depth, though the formation continues, the crushed country 10 feet west of the No. 2 shaft on the 150-feet level being believed to be the same. A formation occurs at the shaft, with veins and lumps of ore, and has been driven on to the south and south-east.

A small ore body, assumed to be No. 2, was struck 40 feet south-south-west of the shaft, on the 300-feet level. It carries from 3 dwt. up to 2 oz. gold per ton.

The country on the west side of the southern portion of the ore body is strongly slickensided.

Ore Body No. 3.—The No. 3 shaft, 240 feet south-south-east of No. 1 shaft, was begun on a small outcrop of gossan 70 feet long and 1 to 8 feet wide, but the large amount of water in the lode prevented exploitation for several years. When the water was finally overcome, the deposit proved to contain some of the richest ore yet found there, and has now, in consequence, been worked out.

At the 50-feet level the body is 100 feet long, and up to 30 feet wide; a strong fissure connects the body with the main fault 100 feet distant. Lenticular masses of quartz, probably older than the ore, occur on the eastern side of the deposit at the 60-feet level. As the ore body pitches towards the north, the southern end passes through the shaft at 90 feet depth at the water level.

On the 90-feet level the ore was 20 feet wide a little north of the shaft, but it gradually contracts to the faulted face, 60 feet from the shaft, where the country is considerably veined with translucent selenite. The country there is a pebble-bearing clay slate, with all the appearance of a "crush conglomerate."

At the 150-feet level ore occurs at the north-east corner of the No. 2 shaft, and also in the shaft, but its relation to the other deposits cannot be seen. The No. 3 body is 130 feet long and 5 feet wide on this level, and is reached by a crosscut from the No. 2 shaft. The ore, 10 to 12 feet in width, has been stoped right to the surface from the level; that underfoot is siliceous, and worth, as far as known, only £2 a ton, but will be made available as a flux, and in working may be found to contain rich ore. A long tongue and several small lenses were followed by a prospecting drive to the south; these lenses of ore occur between the laminæ of the slate, which are themselves often converted into ore, and may be due to the deposition of the ore, for they are not found elsewhere. The drive was carried on along the eastern wall for some distance south of the main body.

Work is now being carried on at 190 feet depth, where there are 10 feet of sulphides, and towards the south 12 inches of clay on the hanging-wall carrying 40 oz. silver. One man during the twelve months prior to October had broken down 400 tons, and is now stoping upwards. The country here is massive grey clay slate; on the east it is shattered, graphitic, and clay-stained.

The ore on the 200-feet level was struck by driving 40 feet south of the No. 2 shaft, when strong gas was emitted by the ore body. The body has quite lately been proved within a few feet of the shaft. Ore has been proved for 40 feet under the 200-feet level. It is 30 feet wide in one place (10 feet of which is poor), but within 30 feet it pinches to 1 foot, and varies from 6 to 12 inches to the winze 160 feet south of the shaft, beyond which the formation

still continues. Ruby silver was first found in the northern part of the body here, and 54-oz. ore is still underfoot. A winze 30 feet deep has been sunk on 2 feet of ore near the end, and proves that the ore at that depth is widening towards the north.

The country on this level is strongly graphitic. Some trouble is now found in identifying the main fault on this level, it having formerly been held that it passed within 2 feet north of the shaft, but there is reason for believing that the fault lying 15 feet north of the shaft is the main one, in which case the few hundred tons of ore north of the shaft may be on the usual (the southern) side of the fault. Numerous lenses have been worked out between the 200 and 100 feet levels on the north side of the shaft. A fault running to the north-west from the shaft proved to have several ore bodies on the northern side, one of which, at 50 feet from the shaft, was followed, and led to the discovery of several other lenses.

Considerable prospecting has been undertaken on this level along the fault north-west of the main shaft, in search of Nos. 1 and 4 ore bodies, but only formations were found, the latter gaseous. The formations will be further prospected by drives to the south, as the ore is generally not well developed near the main fault.

A main winze in the central part of the body passes at 240 feet depth out of the No. 3 body into another coming in from the south (the big body on the 300-feet level). The latter is being driven on to the south at the 250-feet level, and is widening out in that direction. The ore is very fine-grained, and contains lenses of graphitic slate. Work is also going on in the No. 3 body, on the same level, showing it to increase from 6 feet on the south to 15 feet on the north, of which, however, 8 feet is zinciferous (45 per cent. zinc). In the face is a strong fissure—the main fault—near which ruby silver occurs in the ore, causing it sometimes to yield 110 oz. of silver per ton. The deposit here has good walls dipping east, that on the western side being strongly slickensided.

The large body of ore on the 300-feet level was struck 50 feet south of the main shaft by a crosscut, which, after passing through foliated carbonaceous clay slate with irregularly folded lumps of calcite, gradually entered highly zinciferous ore, of which there are 10 feet still standing. The "smelter ore," carrying 30 oz. silver, was then proved to be 30 feet wide, but the ore pinched out within 50 feet to the south, though the formation continues, and appears to be increasing in size; the edge pitches south, an unusual thing in this mine. It was not worked northwards towards the fault because its value decreased. The ore is now being shot down from the stopes above already referred to. A crosscut was continued 25 feet to the east, in search of another body, but except water, lime, and ironstains (promising signs here) nothing was found.

Another body of ore was found by following a fault about 20 feet to the north-north-west of the shaft; it contains ruby silver, and is the richest in lead in the mine. Ore is now being broken down here. The same slickensided graphitic fault with foliated country was followed to the south-east, but only small lenses of ore were found. Driving is still being carried on, the large quantity of chalybeate water being a most encouraging sign.

Ore Body No. 4.—The No. 4 shaft, 110 feet north-north-west of No. 1 shaft, was sunk after the discovery, in 1896, of the No. 4 ore body by a drive, a chain in length, along the fault from No. 1 ore body. The ore, the gossan portion of which carried 50 oz. silver per ton, did not reach to within 35 feet of the surface. With the exception of a little sulphide, the body is now worked out. The average length of the body was 30 feet, and the width 3½ feet, but on the southern and eastern side, above the water-level, the broken country

for 3 feet from the lode averaged 50 oz. of silver per ton, but contained up to 90 oz. per ton. This argentiferous country was discovered by working away auriferous siliceous flux adjacent to it; and very often it was impossible to tell, except by assay, whether the material was silver-bearing or not.

At the 30-feet level a strong "pug" fault, striking north-north-east, and dipping 1 in 3 to the west-north-west, bounds the deposit on the south. At the south end of the 50-feet level 2 feet of 12-oz. sulphide-bearing country has been left for the present. The change from gossan took place at 80 feet depth. At the northern end the face is 15 feet wide, strongly copper-stained siliceous gossan and sulphide ore, with partly replaced "augen" (ore) slate. Innumerable small irregular bunches and veins of ore pass into the country from this body. The ore pinched to a small vein at 90 feet depth.

Intermittent prospecting with a 1-inch handpower diamond drill is going on for the body on the 150-feet level. The hole (now 8 feet in), is being put in diagonally from the drive on the main fault, 50 or 60 feet from the No. 1 body, to catch the formation exposed 20 feet further along the drive, the hope being that ore may be developed as usual at some distance from the main fault. This formation, which is accompanied by a body 1 to 3 feet thick of sulphide and quartz, bends round, and follows the fault for 10 feet to the north-west. Beyond that the fault continues without "pug," mineral, or graphite, and with no sign of other ore body. Lawson's drive, only 20 feet beyond, struck the fault in a similar condition, so that this end seems least favourable for ore bodies.

This body was never highly zinciferous, but was rich in lead and silver, one lot of 1,000 tons of ore yielding a total of 70,000 oz. of silver.

Shaft No. 5.—The No. 5 shaft, known as the Long Drop, lies 260 feet south-east by east of No. 1 shaft, and is 80 feet deep. A fissure—probably parallel to the main fault of the mine, and 1½ chains to the north—was struck, but no ore was found.

Besides these shafts a main mullock pass, a chain north of the No. 3 shaft, connects the 300-feet level with the surface.

Lawson's Shaft.—This, the only other shaft in the immediate vicinity, is just outside the lease, 200 feet north-north-west of No. 1 shaft. It is 71 feet deep, with a crosscut 20 feet long to the fault on the north. No ore was found here.

A small patch of lead carbonate ore occurred on the surface between Nos. 1 and 4 shafts. It worked out at 30 feet below the surface, where it came against the main fault.

There are rumours of a specimen having been found *in situ* in the early days near where the smelters now stand, and prospecting may yet be done there. A little ore was also found in the north-west corner of M. L. 54, but cut out in the trench.

(*h*) Treatment.

The mine being situated on a long slope above the Severn River flats, there has been no difficulty in arranging the surface plant. The ore raised is run in the trucks on an overhead tramway and tipped on to an upper grizzley (1-inch bars with 2-inch spaces), over a second (1¼-inch by ⅜-inch bars and 1-inch spaces). A very small proportion of the fines from the grizzley (3 to 6 cwt. to a charge), is sent to the smelter, a small quantity is spread over the roast heaps, and the greater part goes to a spoil heap, now containing about 1,500 tons, to treat which it is considered a mechanical roaster will be necessary. There have, in fact, been rumours lately of the company undertaking the erection of a roaster for this ore.

Plate 11

Photo., L.C.B.

ROAST HEAPS, SILVER SPUR.

Showing Heap in Course of Preparation, Heap Undergoing Roast, and Roasted Heap.

Photo., L.C.B.

COPPER REVERBERATORY FURNACE, SILVER SPUR.

SHOWING MINE IN THE BACKGROUND.

Plate 12.

Roast.—The coarser and medium ore from the grizzley is then trucked directly along a tramline running over roast heaps, and tipped as necessary. These roast heaps or kilns as they are called, are built up over 2 feet of firewood. The coarsest material (from the upper grizzley), is first thrown down to a depth of 4 feet, and then the ore caught on the second grizzley is tipped and knapped down and spread out by a gang of four men. This is then covered by a thin layer of fines to choke the draughts and prevent fusion of the ore, which is extremely likely to occur, owing to the short time available for the roast. The heaps are 15 yards long, 5 yards broad, and 6 feet deep, and contain on an average 500 tons of ore. Quite lately is has been made the practice to roast the siliceous and basic ores separately, no extra cost being entailed, as the ores generally occur in separate parts of the deposits. One heap of basic ore, containing about 630 tons, was burning during my visit; another of basic and one of siliceous ore had been roasted, and a fourth of siliceous ore was being prepared. The total in the heaps then amounted to 1,500 tons.

The roast takes from two to three months, the sulphur contents being reduced from 28.5 to 14 per cent. Heap-roasting here costs about 2s. per ton of ore (when employing four men on the heaps), and to this amount the firewood (obtained at 10s. per cord) contributes 4½d. When the roast is over it is often necessary to blast down parts of the heap, owing to fusion having taken place.

Reverberatory Furnace.—The roasted ore is carted to the trucks and trammed to the reverberatory furnace, into which it is charged from above. The furnace has a single hearth, and takes a total charge of 84 cwt. (of which 14 cwt. is lime, with an occasional addition of iron ore). This is put through in six or seven hours, making a total of about 15 tons a day. The slags now being produced contain only 2 oz. silver per ton, and the manager is confident that that amount could be reduced by a longer run, which would, however, result in no actual saving.

An attempt has been made to liquate from the old chrome (hearth) lining, when broken up, some of the rich matte absorbed by it; but after the liquation it still contained 150 oz. silver, so an attempt was made to slag off the chromite by the addition of silica. It was found that for the operation to be a commercial success it will have to be done in a blast furnace.

In the operation of smelting the zinc is wasted, but the lead, silver, gold, and copper are saved to a greater or less extent. A parcel of matte shipped in September last ran over 1,000 oz. of silver per ton, and the average content of gold is 1 oz. 6 dwt. per ton (though only a few pennyweights in the ore), amounting to 500 or 600 oz. a year. The following averages of analyses made by Mr. Leon Meston during 1900 are the latest available for the whole process:—

—	Sulphides.	Roasted Ore.	Matte.
Gangue (SiO_2)	14·20	21·43	Trace
Iron	16·14	14·07	5·55
Lead	13·08	10·70	39·30
Zinc	25·30	24·66	2·33
Sulphur	28·50	13·87	19·136
Copper	1·083	1·296	31·50
Alumina, loss, &c.	...	13·974	...
Silver	26·38 oz. per ton	...	1·89
	98·303	100·00	99·676

Later analyses of the ore (also by Mr. Meston) show that the calcium carbonate amounts to less than 1 per cent., alumina to 5 per cent., and arsenic a trace only; also, that during 1900, 1901, and 1902 the amount of silica gradually decreased, the iron decreased nearly 30 per cent., the zinc slightly increased, the lead decreased, and the copper increased very slightly. In connection with the above analyses it may be of interest to give the smelting returns for the year 1901. These have been placed at my disposal by Mr. H. A. Stokes, who was then general manager:—

Ore Smelted.	Flux.	Matte.	Silver.	Gold.	Lead.	Copper.
		Tons.	Oz.	Oz.	Tons.	Tons.
2695·99 tons ...	...	4	2,144	2	1·52	1·29
..	72·45	87·55	47,440	59	22	26·5
..	1·50	...	@ 2s. 3d.	@ £4	...	@ £55
2695·99 tons	73·95	87·55	£5,337	£236	22	£1,457 10s.

The furnace ran 243 days in the year on heap-roasted sulphide ore. The "matte fall" was 3.36 per cent., and a concentration from 29.73 tons of ore was made to 1 ton of matte.

The total smelting costs for 1901, including superintendence, labour (nine men), fuel, flux, stores, ore carting, freights, and bank and insurance charges, amounted to £1 2s. 10d., the grand total (mining and smelting) per ton of ore raised being £2 7s. 6d.

A new reverberatory furnace is now being erected. The diameters of the hearth will be 15 and 30 feet—area 362 square feet—making it one of the largest copper furnaces in Australia, its estimated capacity being 25 tons a day. The hearth, which has a fall of 6 inches in the 30 feet, is built of a course of firebrick on two courses of ordinary brick, above concrete, supported by three arches, through which a current of air will circulate for the double purpose of cooling the hearth, and of becoming heated itself before admission to the furnace. The roof will be 4 feet above the hearth at the upper end, and 3 feet 6 inches at the lower. The fire grate will be 5 feet in length. The furnace will have three side doors for ravelling, and a tap-hole at the lower end. On the sides where the matte touches will be a lining of chrome-brick, in the making of which a considerable amount of experimental work has been done.

The chromite is obtained from Wyalda, in New South Wales, 35s. a ton being paid for it, delivered at Inverell Railway Station. This involves a train journey of 472 miles to Stanthorpe (at, say, 1d. per ton mile), and then cartage over 50 miles to the mine (at 30s. per ton of back loading, otherwise £2 a ton). The hardest and least friable brick thus far has been obtained by the ignition of a mixture of chromite and talc (?) obtained in the mine, but, as the supply of the latter mineral was soon exhausted, recourse had to be taken to ordinary clay, the best results with which were from a mixture of 75 per cent. chromite and 25 per cent. clay.

Blast Furnace.—A small blast furnace was erected in 1900, owing to the then high price of lead (£17 9s. per ton) to treat the old reverberatory furnace slags, which it has been calculated could be made to pay with the price at £13 10s. By the time the first shipment was ready the price had fallen to £11, and operations were then suspended. The slags, of which there is an accumulation of many thousand tons, contain from 4 to 5 oz. silver, 11 to 14 per cent. lead (the latter from the oxidised ore), and 20 per cent. zinc;

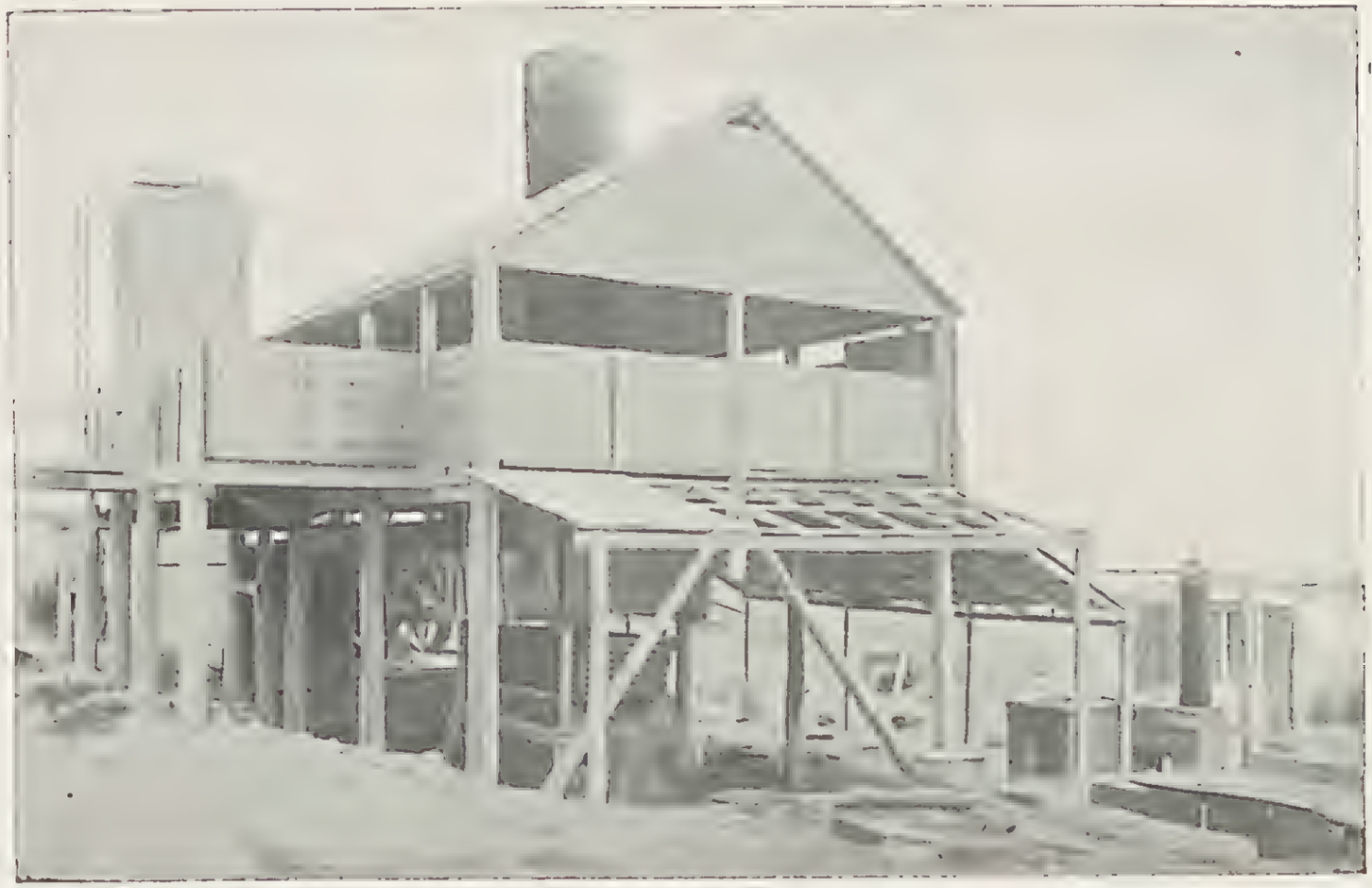

Photo., L.C.B. OLD LEAD BLAST FURNACE, SILVER SPUR.

SHOWING THE BLOWER AND THE SPIRAL TUBULAR WATER JACKET.

Plate 13.

3,721 tons of slag, with 21 tons of ore, were put through during 1901 (163 working days), the actual contents being 7.7 oz. silver, 11½ per cent. lead, 14.6 per cent. ZnO, and 34 per cent. SiO_2, requiring 1,414 tons of limestone (at 6s. per ton delivered), and 399 tons of ironstone flux (at 10s. per ton, delivered at works). As a result, 33½ oz. gold, 28,896 oz. silver, 8½ tons copper, and 188½ tons of lead were saved, at a profit up till December, when the market fell.

The furnace contained a novel feature in its water-jacket (Hickson's idea), which consisted of 3-inch iron pipes coated with clay. These pipes were built up in the form of a rectangular spiral for a height of 4 feet above the crucible, and connected with a reservoir overhead. The water used at that time was very impure, and it was found that the lowermost pipes soon became coated internally, and in consequence were burnt through. Mr. Hall proposes as an amendment that the pipes, instead of being all connected in a single spiral, should be built up as separate rings. A number of taps to regulate the flow of water would then be required, but time might be saved in case a pipe had to be removed.

The brick shaft above the jacket is 10 feet by 5 feet in section, and 8 feet high. This is considered too low, and the cause, owing to the small blast, of the comparatively great loss of metal in the slags—viz., 1 to 2 per cent. lead, 16 dwt. silver, and 15 to 20 per cent. zinc. The blower in use was capable of giving 5,000 cubic feet of air per minute at a pressure of 5 lb., but the actual pressure used was from 6 oz. down to 2 oz. There were 7 tueyeres on each side of the furnace.

Another unusual feature of the work here was the use of coal instead of coke, it having been proved to give a cleaner lead slag than coke, and with a consumption only 4 per cent. greater. The coal was obtained from Fraser's Creek, near Ashford, in New South Wales, 30 miles distant from the Spur, a lease being held by the Silver Spur Company. The cartage to the smelters amounted to 25s. per ton. The ash varies from 6 to 20 per cent., and the carbon averages 62 to 63 per cent., though it runs up to 70 per cent. The following section is shown on the company's plan:—

	Ft.	In.
Hard coal (hanging-wall), worked for smelter ...	9	0
Friable coal (white ash), for smithy	9	0
Hard coal	9	6
Shale, with coal bands	8	0
Hard coal	6	6
Coal	1	10
Shale	6	0

The seams dip 1 in 2 horizontal, and have been worked to 52 feet depth.

Coal occurs also at Bonshaw, nearer Silver Spur, but, like the country, it is crushed and contorted, and contains much pyrite.

Pyritic Smelter.—Before opening out on the 300-feet level it was expected that the ore there would be much poorer in silver, and presumably in zinc also, than that above. A modern pyritic blast furnace was therefore installed, but before arrangements were quite complete for making a start, it was found that very little decrease had taken place in the value of the ore, the contents now being nearly 30 oz. silver, 12 per cent. lead, and 25 per cent. zinc. It was then decided not to employ the blast furnace, the reason given being that one-third of the silver would be lost by volatilisation with the lead fumes, owing to the carbonaceous fuel, but the large amount of zinc in the ore must have been a controlling factor.

The furnace included many of the lastest improvements, some of which were looked upon as experimental, and its estimated capacity is from 125 to 170 tons a day. It is circular in section. The crucible is lined for 2 feet from the base with chrome brick, above which is 2 feet of a hollow air-cooled casting, and then 2 feet 6 inches water-jacket, surmounted by a brickwork shaft 5 feet in height. The firebrick-lined tueyeres (Austin's patent), were designed to act like blow-pipes, producer gas (formed in a patent generator consuming wood), being mixed with the blast air at the moment of admission to the furnace. The reducing fusion and most intense action were thus concentrated at the mouths of the tueyeres.

Another special contrivance is the feeding apparatus, also designed by Austin, to obviate premature fusion of the charge at the mouth of the furnace. By it the flux is charged at the circumference of the furnace, and the ore in the centre; the centre is practically gastight, owing to the fusion of the ore. Fumes and gases were to be taken off below the charging floor, and conducted to a settling flue, 1½ chains long and 6 feet across, before passing to the stack.

Fuel and Fluxes.—The immediate vicinity of the mine is now stripped of timber, and the getters have sometimes to go several miles for the necessary material.

The lime for flux and building purposes is obtained from two localities, the one 4 miles east, the other 6 miles north, of the mine. At the latter place ironstone also occurs, and there is good timber in the same direction, but a stiff climb of 400 feet from the mine on to the tableland 2 miles distant, rather handicaps the locality.

On Hughes' selection, 4 miles east of Silver Spur, are two main limestone outcrops. The southern has a width of about a chain, and a length of 2 chains, striking a little east of north. The rock has a bluish colour, and is marked with white veinlets; it assays 94 per cent. calcium carbonate. No mining or quarrying has yet been done, the surface blocks having been simply broken up and carted away. Two other smaller outcrops occur on the same line, within 5 chains to the south, where the country rock is slate, quartzite, and jasperoid. The limestone forms lenticular masses, and has no sign of fossil remains. At the northern occurrence half a mile distant the blocks outcrop on a flat, and are therefore less easy to load than at the southern locality. The company pays 2s. 6d. per ton for breaking the stone and carting it in to the mine.

The limestone area, 6 miles north of the Spur, is at least a mile in diameter, the rock outcropping at intervals over a wide flat, now covered with a dense growth of weeds, rendering it impossible to determine the exact extent. The area includes slates and ironstones.

The main ironstone outcrop is 6½ miles north of the Mine. It consists of three lenticular masses, separated by a few feet; the central is 1 chain long and 10 feet wide, that on the east is 6 feet long and 2 feet wide, that on the west 6 feet long and 3 feet wide. Their strike is north-west. The central outcrop stood 6 feet above the ground, but several hundred tons have been removed from it for flux. The greater part of the ore is brown limonite, but crystalline magnetite is also sometimes found; parts of it are full of grains of quartz, particularly on the eastern side, where it has a brecciated structure.

Calcareous sinter occurs between the eastern and central outcrops, but the country rock cannot be seen because of abundant red soil and thick vegetation.

A shaft has been sunk 10 yards south-west of the deposit, and passes through slickensided clay slates to a depth of 50 feet. It was sunk in order to prospect the lode for copper, because of a few stains on the surface, a crosscut being carried from the bottom to the lode, but a large amount of water coming in the shaft had to be abandoned. Sinking on the ore, though more expensive, would have given some knowledge of the deposit. It is very unlikely that any quantity, more than a unit or two per cent., will be found here. The following is an analysis by Mr. Leon Meston from a 12-ton lot:—

Fe_2O_3	85·22—*i.e.*, Fe = 59·66
Fe O	
MnO_2, &c. ...	1·69
Al_2O_3	5·50
SiO_2	4·94
H_2O	2·65
	100·00

The ore cost 10s. per ton, delivered at the works (*i.e.*, 8s. breaking and carting, and 2s. explosives).

In conclusion, I should remark that I am indebted to Mr. E. Hall, the present manager of the mine, for much of the above information, but I am under still greater obligation to Mr. H. G. Stokes, the former manager. It was understood from Mr. Hall that the workings have not yet been surveyed and planned. Until the survey has been made no certain geological work can be done in the mine.

II.—TEXAS COPPER MINE.

Texas Copper Mine lies 2½ miles west of Silver Spur, and was abandoned in 1894, so that the surface only can now be inspected. The country rock is siliceous clay slate.

A siliceous gossan outcrop containing a little copper was first worked. At 60 feet depth the copper ore cut out and work was stopped. A vertical shaft was then sunk on a fissure to the north, and several isolated patches of copper ore were found, but nothing further was done on the main line.

III.—SILVER KING SILVER-LEAD MINE.

Silver King Silver-Lead Mine lies 2 miles north-north-west of Silver Spur, and was opened in 1893. The country rock is "knoten" schistose slate, with lenses of limestone. The outcrop of carbonates of lead and copper in gossan was 30 feet long and up to 5 feet wide, the ore having partly replaced a zone of country rock. There were no defining walls, and the ore gradually disappeared at about 30 feet depth. Ore amounting to 30 or 40 tons was raised and yielded 50 oz. silver per ton, and 5 per cent. lead.

IV.—SILVER CROWN SILVER-COPPER MINE.

This abandoned mine lies 4 miles east of Silver Spur. Small pockets of cupriferous gossan in clay schists, dipping 80 degrees to south-south-east, were found near the surface, but galena and copper pyrite appeared at 50 feet depth. The ore assayed from 5 to 40 oz. of silver per ton, and 14 per cent. of copper.

9th March, 1904.

14.—Appendix.

The following additional notes on the condition of mining at Stanthorpe were made during a short visit at the end of May, 1904.

GROUND-SLUICING, SEVERN RIVER.

Mr. Baker, who at the time of my last visit was preparing to work two claims on the bank of the Severn River, below Ballandean, has informed me that before operations had been going on long enough to prove the ground the lease expired, and as an extension could not be obtained the claims were thrown idle. It is understood that only a small quantity of tinstone was saved.

STANTHORPE PROPRIETARY TIN DREDGING COMPANY.

The following returns are from the Warden at Stanthorpe:—

January to April (inclusive) 1904 ... ... 6½ tons tinstone.

Mr. Martyn informed me that six weeks were lost during the quarter, so that the average output of the dredger per working week was 13 cwt. One shift only was working during that time, but in future three will be kept going.

As the result of this measure of success it was decided to carry out certain alterations, and for that reason the dredger has been laid up since Easter. It is expected that work will not be commenced again before the middle of June.

Among the improvements now being carried out on the dredger is the dropping of the top works (tables, launders, &c.) two feet, allowing the drop-shoot to be carried further under the buckets for the purpose of catching sticky material not thrown out immediately the bucket passes the top tumbler. This will also allow more room on the grizzley, where "Martyn's automatic hoes" are to be employed. The "hoes" consist of half-inch iron plate, hung from endless chain-link belts, and travelling along the bars in the same direction as the "wash," but at a greater speed (150 feet a minute), the object of this addition being to break up the clayey material and force it between the bars of the grizzley.

Another alteration is in the sluice-boxes. Four only will be kept on each side, and these have been lengthened to 15 feet, with ten feet between centres of the rake shafts.

During the last few months two dams have been constructed on Quart-pot Creek, one about half a mile above and the other one and a-half mile above the dredger. A third, half a mile above the last, is now under construction, and it is expected that the three will hold 7,000,000 gallons of water, sufficient to supply the dredger for four months. Before the construction of these dams water had to be obtained by pumping from waterholes in Quart-pot Creek into the Chinaman's race, and the difficulty in obtaining water is held to have been the cause of the smallness of the above output.

It should have been mentioned that Mr. Martyn, who is now managing the dredger, held it on tribute from the company till Christmas last, and it was due to his foresight in keeping on till this year, when stanniferous ground was entered, that the dredger was not dismantled.

BROADWATER PROPRIETARY TIN DREDGING COMPANY.

Two of the dams on this company's leases have been repaired since Christmas, and the dredger has been refloated.

Mr. Martyn has found that the overburden and tailings are practically valueless (contrast with the Brisbane Claim, where two-thirds of the tinstone is in the overburden), and they will therefore be raised and deposited without being passed over the tables. The "wash" will then be raised, and it is expected that two tables will be able to cope with it. The material resembling that at Wylie Creek, the arrangement of the plant will be similar to that in operation there, but the boxes will be longer, and will be provided with mechanical rakes as on the Stanthorpe Proprietary dredger.

PROSPECTING ON FOUR-MILE CREEK.

Prospecting operations have now been completed, and though no word has been received from the principals (Messrs. Gibbs, Bright, and Company), there seems to be every probability of the scheme outlined above being carried out. It may be mentioned that ground carrying one and a-half pounds tinstone to the cubic yard is the poorest that will be worked.

SILVER QUEEN SILVER MINE.

This mine has now been taken up by the Messrs. Baker Brothers, who have pumped out the main shaft to the 100-feet level.

Sixty tons of the ore at grass have just been sent to Aldershot for a trial concentration by Wilfley table. Mr. Baker's own assays of the ore on the surface, after concentrating three to one, average:—

Lead	...	...	40 per cent.
Copper	...	...	6 „
Silver	...	...	64 oz. per ton.

This is considerably higher than the return from my rough surface sample from the same ore heaps, and if correct, with lead at £11 10s. per ton, copper at £56 10s. per ton, and silver at 2s. 1d. per oz., the gross value of the concentrates would be £14 13s. 1½d. per ton. Were the reduction company to pay for both lead and copper, which is not very likely, the smelting charges would reduce this amount by at least one-half (*vide* tariffs), unless special arrangements could be made.

Mr. Baker believes the ore can be mined at 6s. per ton, and crushed and jigged for 7s. a ton, and he puts freight and cartage of the concentrates to Aldershot at £1 15s. In my opinion mining costs would be at least 12s. per ton, making the total cost of a ton of concentrates, delivered at Aldershot, £4 12s.

In case no arrangements can be made with the smelters, it might be possible to save all the metals and receive full value by first extracting the copper by a wet process (for which the ore seems to be specially adapted) and then the lead and silver from the residue by smelting.

2nd June, 1904.

By Authority: George Arthur Vaughan, Government Printer, Brisbane.